Detroit vs. Silicon Valley: What's Driving the Proliferation of Automotive Electronics?

by Jason Marsh
INSULECTRO

For the past several decades, modern cars have not changed much. They have four wheels, an engine, a radio (possibly even an 8-track) and seatbelts. Over time, however, cars' electronics parts have evolved faster than any other part of a car with enhancements like power windows, power mirrors, seat heaters and GPS navigation. For the first time in history, the cost of the electronics in the car has surpassed the cost of the raw steel (steel historically represents about 22% of the manufacturing cost). The combination of growing auto demand, coupled with increasing electronic content means significant dollars. IMS Research estimates that the global market for automotive electronics will reach $240 billion by 2020 (Figure 1).

So, what is driving such a rapid proliferation of electronics in automobiles? One report indicates that in the 1970s, luxury car electronics were roughly 5% of the cost of the vehicle's BOM. This climbed to 15% in 2005, and today, including the hybrids and full electric vehicles, this total can be greater than 35%. How important are these new electronics? According to IEEE Spectrum, a late-model S Class Mercedes contains over 100 million lines of code across 70–100 microprocessors for everything from stereo to emissions to airbags, while a Boeing Dreamliner, for comparison, requires about 6.5 million lines of code to operate.

So where is all this growth happening, and what does it mean to PCB designers and fabricators? In the broadest sense there are three general categories that are rapidly evolving (Figure 2).

1. Functional electronics: Critical to the operation of the vehicle, it includes: ABS; automatic transmission control; starters; fuel injec-

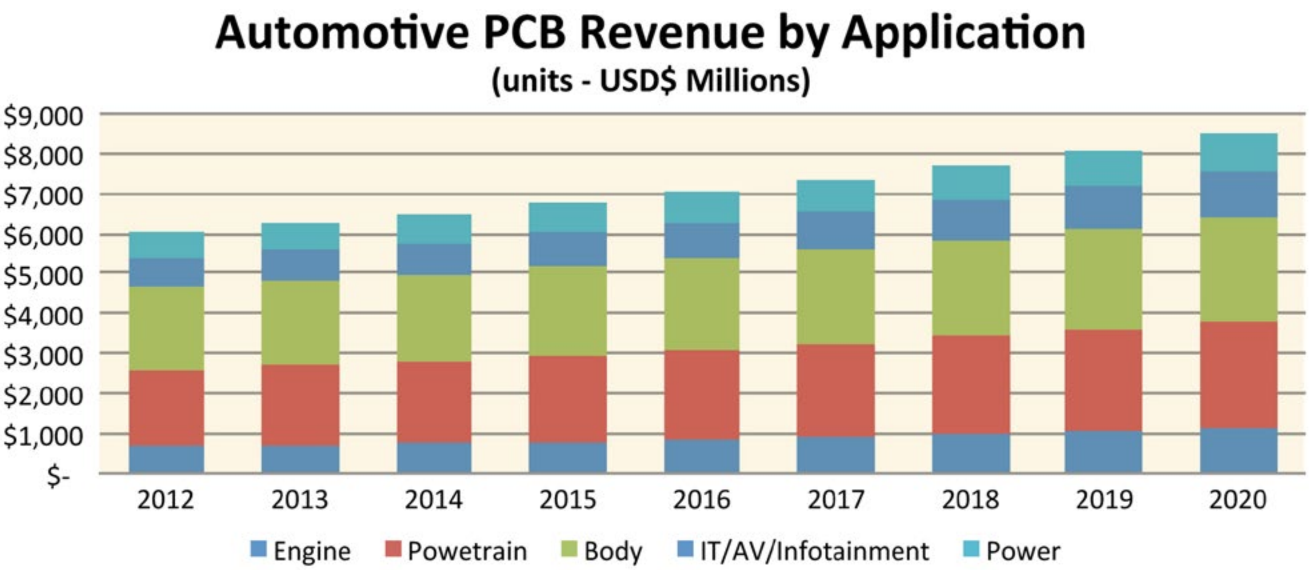

Figure 1: Automotive PCB revenue.

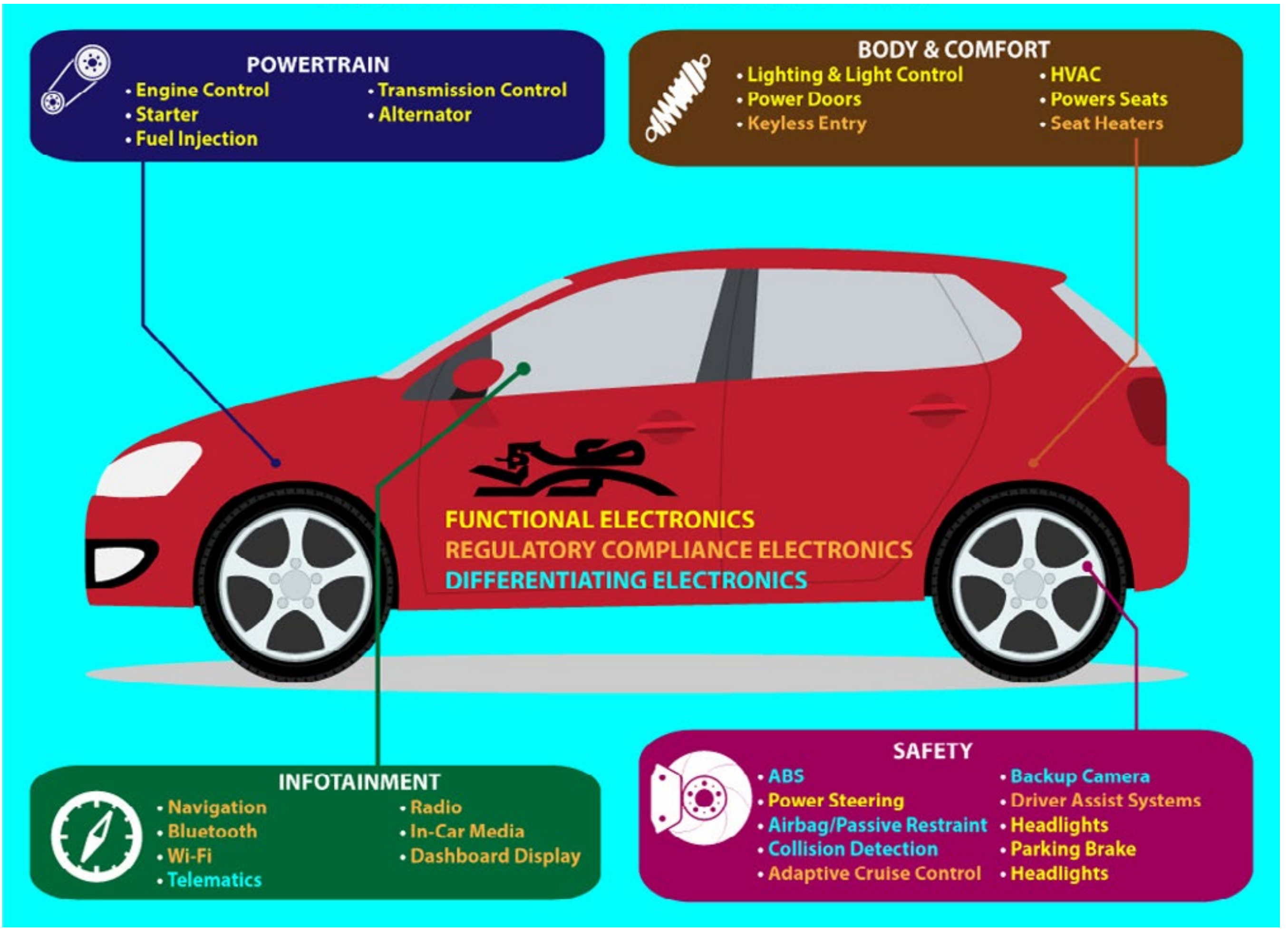

Figure 2: Location of key electronic systems and groupings.

tion; headlights; and electromechanical parking brakes.

2. Regulatory compliance electronics: Regulated into the vehicle by NHTSA or DOT mandate, it includes airbags: emission controls, backup cameras, and collision detection radar.

3. Differentiating electronics: These are unique, consumer-oriented technologies that are designed to convince consumers to purchase the car, including infotainment, adaptive cruise control, Wi-Fi connectivity, and ADAS (advanced driver assistance systems).

Diving deeper, there are key opportunities that could bring near-term growth to the PCB industry. "One of the key growth segments happening now is collision detection radar," explains Dave Barrell of Isola. Operated primarily at 77–79GHz, collision detection radar has already been adopted by the European Commission. By November 1, 2015, all new vehicles in Europe will require advanced emergency braking systems of which 79GHz radar is a critical component.

What makes this so interesting is that automotive radar is really poised to be the backbone of vehicle automation sensor technology, since many of the other proximity detection systems including, lidar, cameras, and even infrared (IR) will lose sensitivity in low visibility conditions. Radar is immune to many of these issues, and when paired with cameras or lidar, creates a very reliable system.

Companies like Rogers Corp. have long focused on these opportunities with PTFE dielectric materials and have strong market share in this arena. New materials from companies like Isola with glass-reinforced alternatives are rapidly gaining popularity as a way to meet cost and yield demands in the auto sector (Figure 3).

Another growth area is the differentiating technology used in the cabin compartment. These include the in-dash display, HUD (heads-up display), and infotainment systems. A significant trend toward full tablet-style touchscreen capability for in-dash systems using dual 17" screens is happening, with Tesla leading the way. Factory-installed HUD systems are already available on some luxury cars and are projected to grow from 3.1M units in 2014 to 33.8M in 2024, according to ABI research.

The communication technologies that include GPS, Wi-Fi, vehicle-to-vehicle (V2V), and telematics are the areas that could see significant growth. Today, Chevrolet leads the Wi-Fi race with nearly all models offering built in Wi-Fi, capable of connecting up to seven devices via 4G LTE.

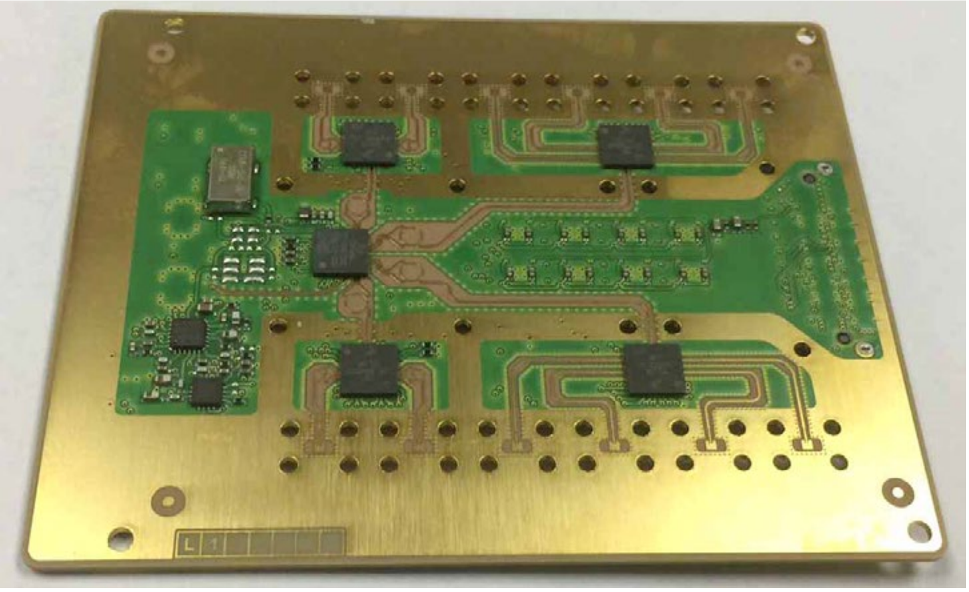

Figure 3: Freescale 79GHz radar demonstration unit using Isola's Astra material.

V2V and vehicle-to-infrastructure (V2X) communication are highly anticipated near-term innovation areas. One thing that is unique about this is that we are talking about a significant amount of data. We are looking at non-stationary systems pushing 10 Gb/s of data or more. Vehicle-to-vehicle communication is critical for self-driving vehicles, and NHTSA's Level 4 Vehicle Automation criteria, so we can expect this to gain traction as ADAS and the component technologies of driverless systems become more prevalent.

This extensive growth affects all aspects of the electronic supply chain. According to IC Insights, the growth for automotive ICs between 2013 and 2018 will lead the industry with a 10.8% CAAGR vs. 5.5% for the industry average, resulting in a total market size of $4.2 billion by 2018. Companies such as Freescale, Renesas, Avago and Infineon are positioned to capitalize on this extreme growth opportunity.

There is also significant innovation happening with printed conductors on both low-temperature and high-temperature substrates. Many of these can be seen in contact switch technologies for cabin lighting or climate control, as well as advanced projective capacitance touchscreen solutions for in-dash control, navigation and infotainment systems. There are even numerous printed electronics parts you don't see, from emissions sensors to mirror defrosters to seat heaters (Figure 4).

Whether the system uses additive conductors, new silicon technology or ceramic-based sensors, nearly all of these systems must incorporate a PCB to function. As a result, the automotive PCB industry is expected to grow to $8.5 billion by 2020, with companies like Mei-

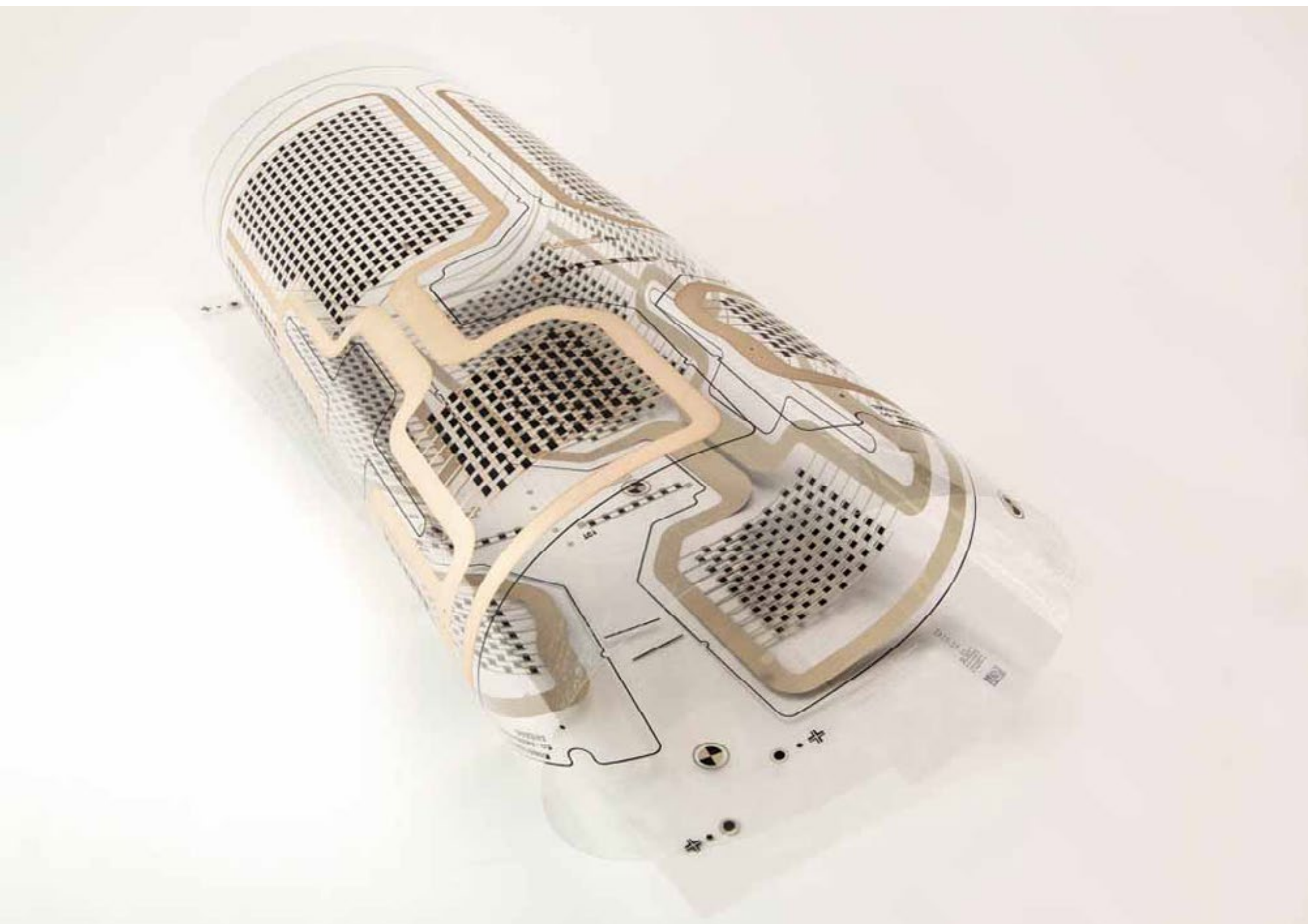

Figure 4: Flexible self-regulating seat heater element made with DuPont printed inks, courtesy of DuPont.

ko, CMK, Chin-Poon and TTM (formerly Via-Systems) leading the volume overseas. In North America, players like American Standard, Saturn and Cirexx are carving out niche spaces with unique capabilities that allow them to make specialized boards for radar, LED illumination, sensors and control units.

According to Yash Sutariya of Saturn Flex Systems, "There are also opportunities for North American PCB fabricators to build prototypes, provide service parts or support emergency production demand."

Newer entrants such as Sanmina are tooling up to enter the space and "consider this an interesting growth area for the company," notes Leo LaCroix, VP of Global Supply Chain.

However, "Traditional automotive isn't the easiest market to get into," points out Anaya Vardya, president of American Standard Circuits. As a fabricator, you have several things to take under consideration. First, most suppliers will need a TS16949 certification for their facility. Finished assemblies may have to undergo accelerated life tests of up to 3000 hours with temperature ranges of -50–150°C. Next, you will learn that the products being produced today began their qualifications as many as six years ago at the beginning of the platform cycle. Tier 1 automotive suppliers will often prefer to make both prototypes and production in the same factory as it greatly reduces the qualification and paperwork challenges. And lastly, the volumes are often significant, but the industry expects annual cost reductions of 3–5% regardless of commodity indices.

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One company who has built a strong portfolio of Automotive PCB sales is TTM. When asked about what was unique about TTM (formerly ViaSystems) that has allowed them to establish this position against strong domestic and overseas competition, John Sintic, VP of Sales–High Reliability and Automotive, explains that, "The key to TTM's success as a preferred automotive supplier is a long history of being a high reliability supplier… [W]e have decades of single digit PPM levels." Another critical success factor is capacity and scale. It is not uncommon for Tier 1 automotive manufacturers to expect their suppliers to be able to respond to 10% capacity surge demand on 48-hour notice. In TTM's case, they have multiple sites in North America and over a million square feet of manufacturing space in their automotive-focused facility in China that allows them to support this need.

Looking forward, there is a great deal of growth potential in areas that are not using PCBs today but where they would make sense from a weight or reliability perspective. According to Clemson University's International Center for Automotive Research, "Today's automotive designs have nearly 100 microprocessors and about five miles of wiring." These wiring harnesses are becoming so dense that manufacturers are running out of space in the columns and headliners and traditional routing channels. That is a lot of potential for flex and rigid-flex circuits and may prove to be one of the great growth areas.

DuPont, the industry leading manufacturer of materials for flexible circuits, continues to build on its portfolio of advanced materials to support the demand for reliable, lightweight flexible circuitry in automotive applications.

"DuPont™ Pyralux® flexible circuit materials are ideal for automotive designs, and we continue to expand our portfolio to meet the market's needs," said Mary Ellen Gustainis, business leader for Americas and Europe at DuPont Circuit and Packaging Materials. "We recently introduced Pyralux HT flexible circuit materials, for example, with the highest service temperature range of any flexible circuit offering, from -40°C up to 225°C." Materials advancements like these are poised to open the automotive market for significant adoption of flex materials.

The next chapter is V2V communication, which will be a cornerstone of ADAS. New antenna designs and lower loss materials will be required for these increasingly high data rates. These subsystems are a stepping-stone for driverless vehicles. Although Google cars, a frequent sight near Google's Mountain View, CA, headquarters are the most well-known, nearly every major auto manufacturer and Tier 1 supplier has a driverless vehicle project underway. Companies like Cadillac, Audi, Ford, Continental, Bosch, and Delphi lead the pursuit. London's Heathrow Airport even has its own POD parking spaces where a driverless vehicle transports you from the parking lot to your terminal. In May, Daimler's self-driving semi-truck was licensed to drive on roadways for testing, and in Australia, mining conglomerate Rio Tinto has self-driving trucks operating at three of its sites. Recently an Uber/Carnegie Mellon project for self-driving cars was spotted on the roads in Pittsburgh.

There is a great deal of development funding going into driverless car prototypes. However, the key to driverless transportation is getting all the systems in the vehicle communicating with each other and with other vehicles on the road. The payback for these efforts? A study conducted by Texas A&M estimates that 90% penetration of self-driving cars in America would double road capacity and cut delays by 60% on major freeways.

As a result of the confluence of these game-changing electronic features, there is a growing collaboration between Silicon Valley and Detroit. Companies like VW and Ford are putting R&D centers in Silicon Valley, and there are plentiful rumors about Apple hiring auto industry executives. Tesla is one of the few auto makers to make PCB design a core competency, and maintains a top level PCB design team in house. This suggests the industry is headed for some significant change and that the trend of electronics growth in automotive will continue.

One area where Detroit and Silicon Valley will likely be at odds is the NHTSA requirement that "automakers must continue to support and supply OEM parts and therefore software for a minimum of 10 years after the model year launch," points out Stacy Duff, president of PAPCO automotive, a major distributor of OEM repair parts in the Silicon Valley Area. Although Ford has been tight-lipped on the reasons for its departure from Microsoft and its alliance with RIM's QNX platform for its Sync 3 Infotainment system, the industry speculates that they came to an impasse over the NHTSA requirements for supporting hardware and software for over a decade, something very uncommon in the consumer electronics industry.

Plus, this level of software and automation opens up major security concerns that will require immediate and aggressive solutions. The publicity surrounding the hacking of the Jeep Cherokee in July will drive the industry to get even more serious about cyber security. Egil Juliussen, senior analyst at IHS Automotive, points out that, "Five years ago, the auto industry did not consider cyber-security as a near term problem…this event shows that cyber-security protection is needed even sooner than previously planned."

So, no matter which area of automotive electronics we are looking at, it seems certain the relentless pace of growth will continue. Based on the number of players looking at self-driving vehicles, we can expect significant milestones in that quest in the near future. All of this automation will naturally create opportunity for reliability and cyber security experts, and all of it will use PCBs. So, if your shop is equipped to participate in this space, there may be some good business opportunity on the horizon.

If all of this sounds like a science fiction novel from the 1950s, just consider that the dominant form of human transportation for the past 3,000 years was the horse, and it has only taken 100 years for that to change forever. All of a sudden, it isn't so fantastic to imagine sitting in a driverless car and catching up on e-mails or watching the news during your commute. **PCB**

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