U.S. Firms Are Becoming Leaders in the Automotive Semiconductor Market

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Two major U.S. semiconductor firms have increased their presence in the global automotive semiconductor market through significant investments. While industry experts project only a small rise in global semiconductor content per vehicle in the next five years, the recent increase in investments indicates that the semiconductor industry believes there is potential for long-term growth in this specialized market.

Vehicle manufacturers add more high-tech features

Many of today's vehicles are sophisticated computers on wheels. For example, the 2016 model of the Ford F-150 truck requires 150 million lines of software code to function.[1] Wider adoption of and consumer demand for enhanced safety features (e.g., lane departure warning, brake assistance, etc.) and fully autonomous vehicles will require still more electronic content and more specialized semiconductors to enable them.[2] By 2019, 15% of all new cars are projected to incorporate electronic advanced driver assistance systems (ADAS), up from only 6% in 2014. Yet market penetration remains limited as today's lower-end, midsize vehicles contain on average only $374 worth of semiconductors, while luxury vehicles contain a much higher average value at about $1,150.

Key automotive functions are expected to rely on increasing electronic (and semiconductor) content, including:

- ADAS: collision warning, blind spot detection, autonomous driving and parking
- Powertrain: motor inverter, battery systems, power management
- Infotainment: audio and video systems, connectivity to the Internet and phones (via WiFi, 4G, Bluetooth)
- Passive safety: airbag deployment, tire pressure monitoring, braking systems

Major U.S. firms are poised to lead the automotive semiconductor market

Global leaders in the automotive semiconductor market have been highly specialized: the Japanese firm Renesas, Dutch firm NXP, and German firm Infineon each derive at least 40% of revenues from the automotive market. By contrast, the only U.S. firm among the top five global suppliers in 2015 was Texas Instruments, a diversified firm with less than 20% of revenue coming from automotive semiconductors. With a few exceptions, major U.S. semiconductor firms have not traditionally focused on the automotive market, being unwilling to accommodate a higher degree of specialization or tolerate the lower profit margins required to survive in the market.

In 2016, however, a clear break from past business practices was evident. In July, Intel (U.S.) announced an alliance with BMW (Germany) and Mobileye (Israel) to create a fleet of fully autonomous vehicles by 2021. In October, Qualcomm (U.S.) agreed to acquire NXP for $47 billion in a move that will make it the world's leading automotive semiconductor supplier (table 1). The entrance of these two industry leaders, along with other major automotive initiatives for hybrid, electric, and autonomous vehicles (e.g., by Uber, Apple, Alphabet, Tesla, General Motors-Lyft, and others) is beginning to tilt the global automotive semiconductor market towards U.S. firms.

Table 1 Top five global automotive semiconductor suppliers in 2015

Company name (country headquarters)	2015 share of company sales in automotive semiconductors	2015 automotive semiconductor sales (billion $) and global market share
NXP (Netherlands)*	29 percent*	$4.1 (14.5 percent)*
Infineon (Germany)	41 percent	$2.8 (10.1 percent)
Renesas (Japan)	41 percent	$2.7 (9.5 percent)
STMicrolectronics (Switzerland)	29 percent	$2.1 (7.5 percent)
Texas Instruments (U.S.)	15 percent	$1.8 (6.5 percent)

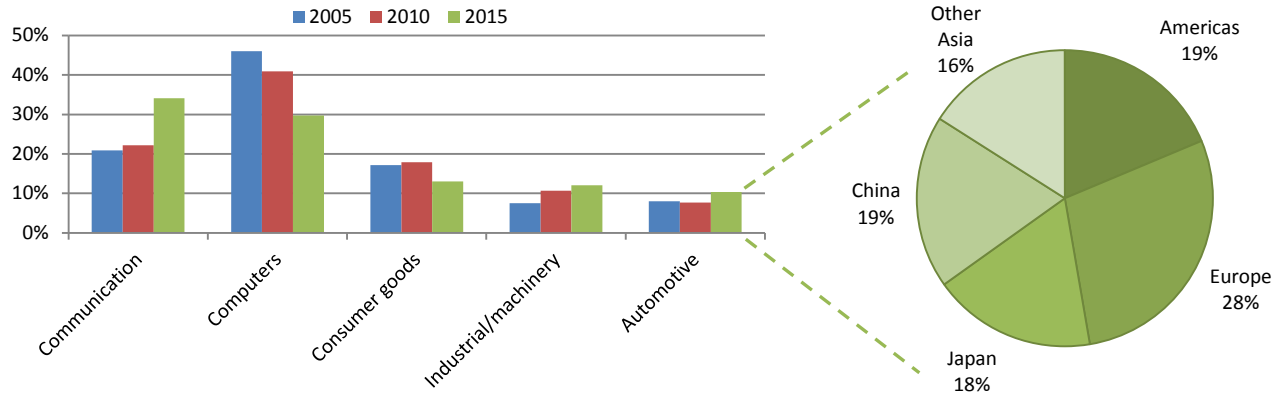
Sources: Semicast Research, press release, April 4, 2016; Renesas, *Financial Report 2015*, March 31, 2015; STMicroelectronics, "Form 20-F," annual report for SEC, March 3, 2015; Infineon, *Annual Report 2015* (accessed January 14, 2016); Texas Instruments, Inc., "Investor Overview," 2015; Investor Deck: Qualcomm to Acquire NXP," October 27, 2016.
*Under the Qualcomm-NXP merger announced in October 2016; estimates for post-merger revenue from "Auto, IoT and other."

[1] In comparison, the typical smartphone operating system has roughly 12 million lines of code.
[2] Automotive semiconductors include integrated circuits, graphic cards, processors, transceivers, various sensors, and analog devices.

Semiconductor content in passenger vehicles is increasing modestly

Since 2010, automotive semiconductors have become a small, but growing and reliable, revenue driver for some U.S. firms due to the sustained growth of electronic features in vehicles. For example, firms such as Nvidia, On Semiconductor, Linear Technology, and Texas Instruments each experienced at least a 12% per year revenue increase from sales of automotive semiconductors from 2011 to 2015. Overall, automotive semiconductors made up 10.3% of worldwide semiconductor end use in 2015, a modest increase from 8% in 2005 and 7.7% in 2010 (figure 1). Europe, home to various producers of luxury vehicles, accounted for the largest automotive semiconductor market in 2015, and it is likely to continue as a key market.

Figure 1 Global semiconductor end use by sector (2005 to 2015) and auto semiconductor consumption by region in 2015



Source: Semiconductor Industry Association (SIA), WSTS End Use Surveys, 2005, 2010, and 2015.

Automotive semiconductor growth is driven by vehicle volume

The global automotive market has the potential to occupy a larger share of semiconductor use while growth slows in other, largely mature sectors (such as computers and consumer goods). But for now, it remains a limited market. In the next five years, increased global vehicle production of 3.3% per year is expected to be the primary driver of automotive semiconductor growth, while semiconductor content per vehicle in terms of value is projected to grow by only 1.1% per year. Growth rates of per-vehicle content value will likely remain relatively low for three reasons: (1) the declining cost of semiconductors due to increasing production efficiency and competition; (2) the relatively slow rollout of technology in vehicles due to safety, reliability, and regulatory concerns; and (3) the rapid growth in sales of vehicles with relatively low semiconductor content in lower-income countries (e.g., some manufacturers are only now installing airbags in all of their vehicles worldwide in response to rising affordability and demand). In order to achieve further growth, applications for electronic content will need to filter down from luxury autos to become standard features of vehicles in lower price brackets.

Vehicles are developed, produced, and used over a longer time period than consumer electronics, and have lower replacement rates and tolerance for failure. For automotive applications, reliability and cost are more important than processing speed; hence, cutting-edge processes are implemented slowly. Furthermore, semiconductor suppliers face longer planning horizons and lead times than vehicle manufacturers and thus adjust their supply chain less frequently. Despite the entrance of new major firms into the market, these fundamental hurdles to sustained success in the automotive semiconductor market are unlikely to change significantly. U.S. competitiveness in this market is increasing rapidly as a result of recent investments. The semiconductor and automotive markets are likely to be shaped by U.S. firms' ability to patiently navigate these challenges.

Sources: Ulrich Schaefer, "End-Use Session: Automotive Electronics," WSTS 2015 Autumn Forecast Meeting, November 17, 2015; Semicast Research, press release, April 4, 2016; Wells Fargo equity research, December 29, 2016; Renesas, *Financial Report 2015*, March 31, 2015; STMicroelectronics, "Form 20-F," report for SEC, March 3, 2015; Infineon, *Annual Report 2015* (accessed January 14, 2016); SIA, *End-Use Report*, 2015; Jim Hines, "Connected Cars and the Internet of Things," Gartner, 2015; Christoph Forster et al., "Collaborative Value Chain Management between Automotive and Semiconductor Industry: An Analysis of Differences and Improvement Measures," 8th Conference on Intelligent Computation in Manufacturing Engineering, 2013; Ford Motor Co., "Ford Invests in Pivotal," news release, May 5, 2016.