Coughlin Associates

The Case for Agile Workflows in the Auto Industry

Coughlin Associates, Inc.
9460 Carmel Road, Atascadero, CA
https://tomcoughlin.com

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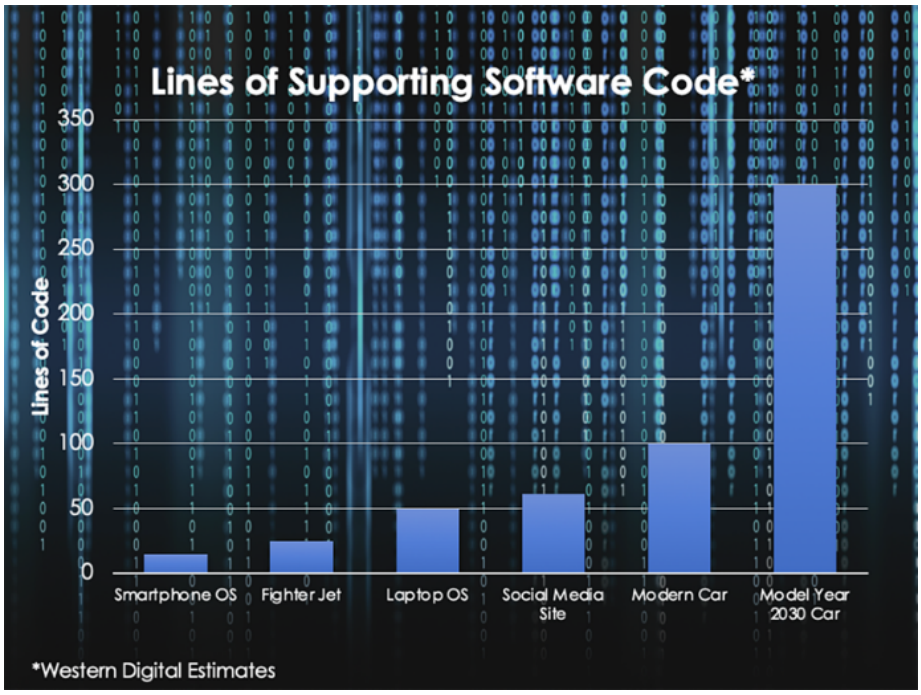
Introduction

The rise of new competitive automotive companies and the recent pandemic are driving new and more agile development processes in automobile design and manufacturing. These new agile processes are also helping automobile companies acclimate to the semiconductor challenges brought on by global forces that hobbled automobile production in 2021 and even into 2022.

Auto companies adopting agile processes soonest, best and most effectively will be at a distinct, measurable competitive advantage for three reasons: 1) they use parts more in tune with mainstream semiconductor products; 2) they work faster, with more processes happening simultaneously; and 3) their earlier execution can lower costs and increase profitability.

With these changes and the requirement for more and more automotive electronics to enable advanced driving features, infotainment and the growth in production of electric vehicles, the demand for digital storage and memory is increasing. Indeed, the lines of supporting software code in automobiles already outstrips the amount of code in a fighter jet, laptops and social media sites, and is expected to continue to grow dramatically.



Storage and memory also play an increasingly important role in enabling more agile automotive design and manufacturing and enable today's and tomorrow's feature enriched automobiles.

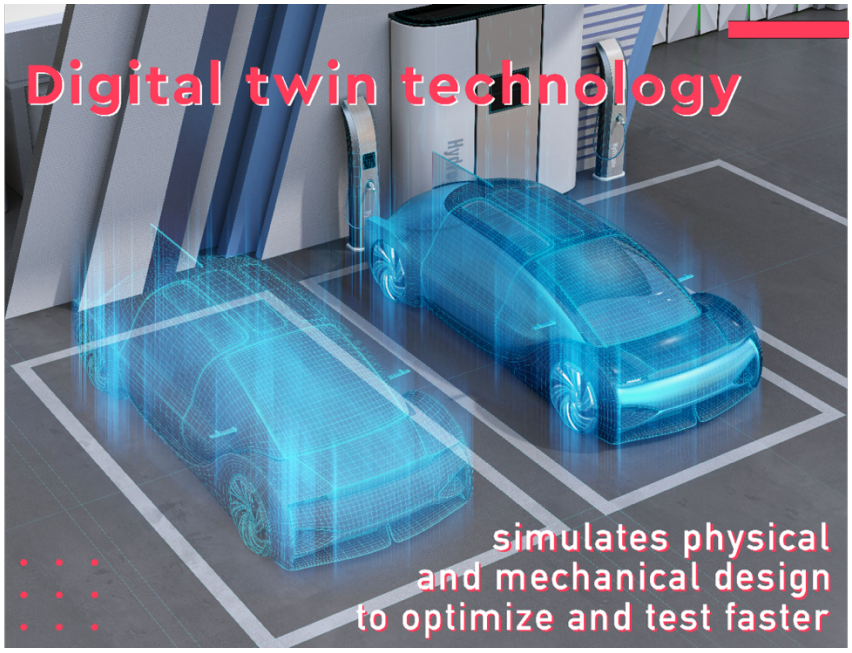
This paper looks at four rapidly changing dynamics that automakers need to consider when adopting agile workflows to optimize for future productivity gains. These include:

1. **development and qualification processes** – improving time-to-market and enabling quick transitions to newer technologies
2. **hardware technology** – adopting the latest in semiconductor advancements for competitive, first-mover advantage and potential cost savings
3. **platforms** – creating upgradable, agnostic hardware and software platforms that can be adopted and implemented quickly for consistent, incremental improvements
4. **collaboration** – leveraging feedback loops to ensure future needs are both anticipated and met with the least amount of friction

Development and qualification processes

Traditional automotive companies have worked to reduce the development times for new cars for many years. With competitors increasingly using the fast development time of cutting-edge semiconductors as a model for automotive development, the pressure to reduce development time and implement new technologies into the automotive industry has accelerated.

Also, during the pandemic, automobile companies leveraged artificial intelligence (AI) in manufacturing to automate development activities, further enabling faster response. At an industry event in April 2021, BMW spoke on how it used digital twin technology to optimize the operation of its automotive assembly factories, including many robotic functions, in real time[1].



Digital twins are computer models of real devices or systems that emulate the properties and operation of the modeled entity to great precision – and these computer models can be used to optimize and test the modeled entity faster than physically operating on the device or system. Digital twin technology – as it continues to improve – will be an important element in accelerating automobile design and manufacturing.

"To a large extent, automobile companies are driven by their manufacturing processes," according to Brett Smith from the Center for Automotive Research (CAR). "The use of technology to improve factory quality, yield and production volume will be important in the industry's successful evolution," he added.

[1] BMW Group and NVIDIA take virtual factory planning to the next level, BMW Press Release, April 13, 2021.

Hardware Technology

Semiconductors have become among the most important components in modern cars, and automotive OEMs are placing a higher priority on sourcing semiconductors. OEMs are moving towards sourcing and buying directly from semiconductor suppliers, including foundries, rather than treating semiconductors as a Tier 2 component, sourced indirectly from subcontractors.

Some examples of this include Ford partnering directly with Global Foundries in November 2021 as a Tier 1 product supplier to increase the company's short- and long-term supply of semiconductor chips[2]. Other chip suppliers such as Qualcomm also are increasingly being treated by semiconductor OEMs as Tier 1 component suppliers and key partners in offering new features for the next generation of vehicles.

At the 2022 CES conference, Qualcomm indicated that its Snapdragon Digital Chassis for connected and intelligent vehicles includes many features which will become increasingly valuable as the industry moves to EVs[3]. Some particularly interesting features of the Digital Chassis include a vehicle digital twin that manages the vehicle over its lifecycle and allows the latest software to be tested and then pushed to the edge and to the vehicle. This is combined with a software-defined vehicle approach that uses cloud-managed and microservices-based architectures to run some applications independently of the underlying hardware architectures.

This kind of thinking provides new opportunities for designing, developing, testing, diagnosing and updating the vehicle. This architecture accounts for functions that require strict adherence to hardware and embedded software to ensure safety, security and low latency while enabling flexibility for functions that work better as a microservice.

EVs will require expected lifetimes similar to conventional cars and much greater than many mass-market consumer devices. This may require new hardware architectures that are modular, blade- or cartridge-based, allowing for upgrading hardware to enable longer overall vehicle life.

Moving some vehicle functions from strict hardware control to software control will be an important element to enable some replacement of hardware, including semiconductors, while maintaining vehicle functionality. This could provide more component sourcing flexibility and the avoidance of future automotive semiconductor shortages. Modularizing hardware upgrades will also help to keep vehicles up to date through their lifespan.

In addition to these chip and software defined architectures, new approaches to product design may help automobile companies to qualify lower lithographic node (mass market

[2] GlobalFoundries, Ford to Address Auto Chip Supply and Meet Growing Demand, Ford Press Release, Nov. 18, 2021.

[3] CES 2022: How the Snapdragon Digital Chassis is transforming the automotive industry, Qualcomm Blog, Jan. 4, 2022.

semiconductor) products. These include the use of digital twins for vehicle testing to reduce dependence upon physical testing as well as moving to a more parallel design approach to automotive systems, tied to a software defined architecture, to create a more agile design process common in other technology industries.

Platforms

There are many factors driving the use of more semiconductors in automobiles, including memory and storage. Semiconductors are used for advanced driver-assisted systems (ADAS) systems (including embedded AI systems), for car-to-car and car-to infrastructure communication, for infotainment and telematics, for powertrain control and even for automotive body and convenience features. In addition, EV growth will further drive demand for automotive electronics.

Among U.S. light vehicle production, memory ICs and sensors will be among the top seven highest volume automotive semiconductor categories with over one billion units used annually by 2030, according to S&P Global Mobility, formerly the automotive team at IHS Markit[4]. It is estimated that, in 2020, seven percent of automotive semiconductor devices were memory and storage[5].

S&P Global Mobility also estimates the sensor demand for various lighting and biometrics functions will result in a 42.9 percent cumulative annual growth rate (CAGR) in semiconductor volume out to 2031 in the 45-110nm segment.

To store the information from these sensors and other electronic functions for AI processing and other uses, S&P Global Mobility forecasts a 28.4 percent CAGR in memory ICs (LPDDR, DRAM and NAND flash) in the 10-18nm segment, resulting in 1.2 billion memory ICs shipped in 2031 for U.S. light vehicle production[4].

Electrified (which includes hybrid) vehicle sales are growing. For instance, the U.S. the market share rose from about 4.3 percent in 2019 to 9.5 percent in 2021[6]. Political mandates will drive this future demand. For instance, President Biden called for a goal of 50 percent sales of emissions-free vehicles by 2030[7], and automakers have announced significant spending on EVs. Ford announced spending $30B USD over five years[8]; GM said it would spend $35B USD through 2025[9]; Mercedes-Benz said it would spend $60B Euros by 2026[10]; and VW will spend

[4] IHS Markit Custom US Light Vehicle Semiconductor Demand Forecast, June 2021
[5] U.S. International Trade Commissions, Executive Briefing on Trade, May 2019.
[6] Semiconductors and Automotive—What's at Stake?, Bernard Swiecki, CAR, presented at SEMICON West 2021
[7] Biden, in a push to phase out gas cars, tightens pollution rules, New York Times, August 5, 2021,
[8] Ford growth plan, $30 billion in electric vehicle spending wows investors, The Detroit News, May 26, 2021
[9] GM Will Boost EV and AV Investments to $35 Billion Through 2025, GM news release, June 16, 2021
[10] Supervisory Board confirms Business Plan: Mercedes Benz to invest 60 billion euros into the future, Mercedes Benz news release, December 2, 2021

$100B USD over five years[11]. Several automotive companies have announced that most of their automotive sales will be EVs by 2030 or shortly thereafter.

Electric vehicles will require even more electronics, and combined with ADAS (including AI), infotainment, cloud communications, powertrain control and convenience features will drive automotive semiconductor demand. This includes growth in feature-agnostic solid state digital storage and memory in automobiles.

Collaboration

As cars develop more autonomous features and more types and volumes of data are created, the need to manage all these applications requires strategic planning, careful coordination, and smart execution. An agile workflow with a parallel design approach, tied to a software-defined architecture must be adopted and ascribed to by semiconductor suppliers, Tier 1 suppliers and OEMs. This is at the core of the industry succeeding as a whole.

"Being agile means keeping an active feedback loop," said Russ Ruben, Director, Technical Segment Marketing, Western Digital. "The feedback loop is important for electronic components makers, Tier 1 suppliers and automakers – enabling them to coordinate designing in a new feature for a future product that requires a component supplier to modify their product to enable the feature. Likewise, processors, sensors and data storage technology advancements need to be communicated timely to automakers and Tier 1 suppliers so they can take advantage of the latest features. This robust feedback mechanism is the connective tissue that aligns the industry and electronic component suppliers more efficiently and effectively."

Another critical feedback loop for the global storage maker is with automotive systems designers – helping them calculate a car's potential data workload accurately. Without planning ahead when vehicle systems are being designed, a car could end up wearing out the storage in an ADAS, or an eCockpit, or infotainment system before the car's life is over.

Part of this, says Ruben, is knowing that the endurance of the storage device depends on the amount of data written (measured in terabytes) and varies based on the capacity of storage. Every device has a limit, so it is important to determine the data write requirements based on real system workloads over the lifetime of the vehicle.

Understanding the future workloads of software-based vehicles is becoming a bigger challenge for hardware engineers. They need to plan for unforeseen scenarios requiring more capacity for software updates as well as how the updated software will read and write to the storage devices.

Western Digital also believes companies can be more agile by creating more cross-functional teams, where there is constant collaboration towards a common goal. Traditional work

[11] Volkswagen increases spending on EVs to $100 billion, CNN, December 9, 2021.

structures have separate groups competing for resources, which are rife with hand-offs, miscommunication, duplication of efforts, and delays.

Western Digital's storage business spans flash and HDD technologies, with an eye on solutions ranging from cloud to onboard storage. The San Jose-based company has instituted rigor across its cross-functional engineering, manufacturing and marketing teams globally.

Conclusions

Leading semiconductor and storage companies are helping to bring new vehicles to market in a more efficient and effective manner. They are helping to optimize the industry's success with innovations such digital twin technology that manage the vehicle over its lifecycle, right-sizing storage to match the lifetime of the car, and adopting more parallel workflows in testing and certification.

About the Author

Tom Coughlin, President, Coughlin Associates is a digital storage analyst as well as a business and technology consultant. He has over 40 years in the data storage industry with engineering and management positions at several companies.

Dr. Coughlin has many publications and six patents. Tom is also the author of Digital Storage in Consumer Electronics: The Essential Guide, which is now in its second edition with Springer. Coughlin Associates provides market and technology analysis as well as Data Storage Technical and Business Consulting services. Tom publishes the *Digital Storage Technology Newsletter, the Media and Entertainment Storage Report*, the *Emerging Non-Volatile Memory Report* and other industry reports. Tom is also a regular contributor on digital storage for Forbes.com and other blogs.

Tom is active with SMPTE, SNIA and the IEEE, (he is Past Director for IEEE Region 6, Past President of IEEE USA, Past Chair of the IEEE New Initiatives and Public Visibility Committees and active in the Consumer Electronics Society) and other professional organizations. Tom was the founder and organizer of the Storage Visions Conference (www.storagevisions.com as well as the Creative Storage Conference (www.creativestorage.org). He was the general chairman of the annual Flash Memory Summit for 10 years and is currently Program Chair. He is a Fellow of the IEEE and is Chair of the Consultants Network of Silicon Valley (CNSV). For more information on Tom Coughlin and his publications and activities go to www.tomcoughlin.com.