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Roland Berger

IMPACT OF THE SOFTWARE-DRIVEN CAR

How Autonomous Cars Will Alter the Auto Industry and Life as We Know It

WHEN IT MATTERS, IT RUNS ON WIND RIVER

EXECUTIVE SUMMARY

For consumers, speculating about the implications of the self-driving car is fun and exciting. Will it mean no one needs to own a car? Will we still need a license to be driven by a car? Will it spell the end of traffic jams and parking garages? Will it make us safer or introduce new risks? And when will autonomous cars move off the drawing board and onto the road?

For many auto industry leaders, the excitement about autonomous vehicles is coupled with anxieties and uncertainties. One senior executive recently voiced his fear of "waking up one morning and having been 'Ubered.'" In his words, "Companies from completely different industries can take away your regular business model overnight."

Autonomous vehicles are clearly inevitable, and they will likely have a dramatic impact on the way consumers live, work, and play. But what are the most probable outcomes, short term and long term, for consumers and for the 130-year-old auto industry? And what steps should automakers now take to avoid being left in the lurch?

This paper examines how the autonomous car and other software-driven innovations will change traditional consumer buying habits and automotive business models, and what is fueling this business transformation.

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THE CONNECTED AGE CHANGES EVERYTHING

Before any prophecy about the future of the autonomous car can be truly meaningful, we must address the big-picture context. The vision of the self-driving car is a key factor in the current sea change that is overhauling the auto industry. Consider these potential outcomes and their impact:

- **Deaths, injuries, and medical expenses radically reduced:** Self-driving cars can eliminate most of the accidents that currently result in the deaths of more than 1.24 million people worldwide each year.[1] Studies show that 95 percent of accidents are caused by human error, and even accounting for software errors that lead to accidents, the total injury rate will be far lower than today, dramatically reducing medical costs.[2] In the U.S., motor vehicle crashes cost almost $1 trillion each year in medical expenses and loss of property and productivity, according to the National Highway Traffic Safety Administration (NHTSA).[3]
- **Individual car ownership significantly decreased:** The autonomous car may usher in a new robo-cab or "mobility as a service" model in which car service is simply ordered online and fulfilled by fleets of ubiquitous, self-driving vehicles. In this model, the automotive experience is personalized not by the make and model or hardware accessories of the car but from the inside via software—for example, via the music, video, and web services it has available. Uber CEO Travis Kalanick indicated in a recent tweet that he expects Uber's fleet to be driverless by 2030.[4]
- **Auto insurance, parking garages, parking spaces—who needs them?** If a growing mass of consumers choose not to buy cars, they will not need auto insurance, which costs an average of $907 U.S. per year, according to a study commissioned by Quadrant Information Services. As for parking garages, they will no longer need to be an integral part of every detached home, nor will parking garages and parking spaces need to occupy huge stretches of extremely valuable real estate in cities. While commercial fleets will still need these, they can be located outside of consumer-dense hubs. Clearly, the economic repercussions are staggering.
- **Traffic jams—a distant memory:** With the rise of autonomous cars, advancements in traffic management and ride sharing will ease traffic congestion. Vehicles sharing the pavement will get to their destinations faster because they'll use software to optimize everything from routing to communications with other vehicles and the road infrastructure. Traffic congestion costs Americans more than 4.8 billion hours of time and 1.9 billion gallons of wasted fuel each year, translating to $101 billion in economic impact every year.[5]
- **Environmental impact—major strides for the planet:** Most experts agree that the vast majority of autonomous cars will be electric. Even with traditional vehicle engineering, modern electric cars get the equivalent of 120 MPG, and electricity production is much cleaner than gasoline production. This translates to about a 50 percent savings compared to traditional automobiles.

THE IMPACT ON THE AUTOMOTIVE INDUSTRY'S VALUE CHAIN

The predictions and statistics cited above are just the tip of the iceberg for consumers. The key point is that these changes may also fundamentally alter the auto industry—and the global economy.

Behind all of this change, in fact, what is making all of these innovations possible is this: software. The auto industry is undergoing a software revolution. The next generation of automobiles, be they autonomous, connected, shared, or electric, is being driven and differentiated by its software. Software has changed the game.

Automakers are struggling to come to terms with the car becoming a deployment platform for new software innovations. They see that software has become more and more ingrained into the functionality, the experience, and the dynamics of the vehicle—from dashboard instruments to the power train to safety systems to in-vehicle infotainment (IVI)—and an increasingly large percentage of the vehicle's perceived value will be software driven. Given the increasing impact that software is making to the value of a car, automakers are seeing a greater need to better "control the software." And that requires a transformation.

> "The time for transformation is clearly at hand. Failure to adapt and invest in digital platforms will mean risking displacement across the industry. The automotive landscape as we've known it has completely changed."
>
> —Marc Winterhoff,
> Senior Partner, Roland Berger

Many automakers have responded by investing in software start-ups to accelerate innovation and learn the ropes in the software business. Others are investing in new ecosystem partners to gain a foothold in new business models. For example, GM has made a major investment in Lyft, Toyota has invested in Uber, and Volkswagen has made an investment in Gett.

However, buying start-ups and investing in new market entrants alone will not deliver a transformation. In fact, the gap is actually widening between current auto industry digital maturity levels and the ability to exploit digital opportunities, according to consultancy Roland Berger. In their recent study of German manufacturers, only about one-third rated their own digital maturity as high or very high. On average, strong ratings were more prevalent among larger and more profitable companies: 62 percent of firms with EBIT margins upward of 15 percent affirm they possess high or very high digital maturity levels. But a breakdown of the responses by industry puts chemicals, logistics, and energy systems in front of the automotive industry.

What does transformation and digital maturity look like for the auto industry? It means replacing the linear transactions between suppliers, carmakers, and customers with a more dynamic model (see figure below). The good news is that the innovations of the connected age can benefit everyone in the automotive ecosystem. The increasing capabilities of connected software will enable automotive supply chain partners to communicate and collaborate more effectively in real time. Fully connected smart companies can organize countless supply chains in parallel and dynamically align their offerings to trends as they emerge.

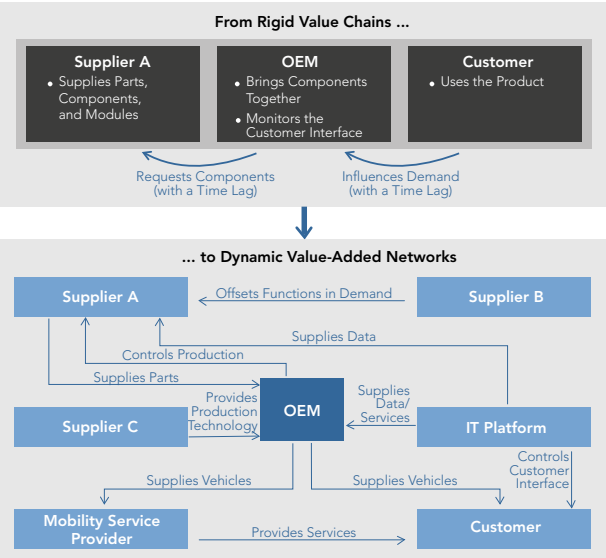

Figure 1.

FIRST STEPS ON THE TRANSFORMATION JOURNEY

With so many elements converging within the industry, such as increasing connectivity; automated driving; and the resulting exponential growth of data, plus the requirement to intelligently manage it, automotive systems are becoming more complex than ever. What then is needed to tackle these new demands and usher in the next-generation automobile? The true agent of change is software. More specifically, it is becoming vital to develop software that enables ever-smarter interconnections and interactions among the myriad of systems within and around the vehicle. Simply put, automakers are now in the software business, whether they acknowledge it or not. Software and connectivity drive an increasing share of the auto's value chain, and future innovations in software and the hyper-connected Internet of Things will be the source of competitive advantages and business value.

To cite just one recent example: It's said that Tesla is now viewing its entire vehicle design as an upgradable system, with power train performance as a software-upgradable function and its autopilot capabilities as a marketplace app. How valuable are software-oriented features to consumers? A survey conducted by Tesla shows that consumers in the U.S., Germany, and China were all willing to pay a high premium of $3,000 U.S. for an autopilot upgrade.

> "The magic behind the connected and autonomous car is the software, and that magic has already cast its spell on consumers. Consumers have had a peek at the car of the future, and there is no turning back."
>
> —Marques McCammon,
> General Manager, Connected Vehicle
> Solutions, Wind River

For automakers, a digital transformation means embracing software-driven capabilities and innovations that are available today as well as actively working toward a longer-term vision, including the integration of Big Data insights into greater business opportunities, broader use of SMAC (social, mobile, analytics, and cloud) technologies, and exploration of opportunities from the Internet of Things.

A good starting point for forward-looking carmakers is to focus on software integration. To date, the evolution of the autonomous car has proceeded in a piecemeal fashion: Many software capabilities were developed via one-off academic projects, often by smaller research teams with little production-level experience of related software elements specific for the automotive environment. Other software components—from the software driving the electronic control units (ECUs) that power dashboard instruments to IVI systems to embedded safety features, telematics, and power train functions—are evolving separately and are not well integrated. What's needed is a software platform with the ability to integrate the diverse software elements, sensors, and driving systems of the autonomous vehicle.

> "The evolution of the automobile will demand a new perspective. Carmakers will begin to see the automobile as another connected device within the Internet of Things. Within five years, a car will connect, communicate, and exchange data with the things around it—other cars, traffic lights, buildings, and even power grids within our smart cities. Imagine fewer accidents and traffic, cleaner air, and more free time during a drive. The concept of a commute will be redefined forever."
>
> —Marques McCammon

Decentralized systems using multiple sensors and ECUs to deliver limited advanced driver assistance system (ADAS) functions—such as rear parking cameras, adaptive cruise, blind spot detection, lane departure alert, emergency braking, and emergency assistance—must evolve to partially centralized systems for safety features and functionality such as self-parking, lane keeping, smart stop, vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, advanced navigation, Wi-Fi hot spots, and a range of assistance with informational and monitoring applications. This means that the various complex systems within the vehicle must communicate and work together in order to create the advanced connected capabilities of the car of the future, and do it securely.

Moreover, two separate networks are evolving separately, and these will need to work together as well: the intra-car network (also called the intra-car cloud) and the broader external network of the outside world, commonly referred to as the Internet of Things. Ultimately, the car's software platform will need to accommodate the convergence of these two networks.

Equally important, as the car becomes a more intelligent device, automakers can begin leveraging Big Data analytics into an increasing range of capabilities. As massive amounts of data travel to and from the car, carmakers have the opportunitiy to take these insights and make them actionable. For example, they could use real-time analytics to determine and offer appropriate on-demand services to the consumer, or diagnostics and vehicle usage data could educate carmakers on how to continually improve performance and reduce costs.

> "There is a chasm between Detroit and Silicon Valley. The auto industry is realizing they need to adopt new tech and adapt to a faster rate of innovation. And the software world needs to understand the regulatory and structural challenges inherent in a 130-year-old auto industry. Who will the winners be in this new era of autonomous cars? It will be those who have the diverse skill set to unite the two worlds together."
>
> —Marc Winterhoff

THE TIME FRAME AND THE IMPACT ON CONSUMERS

The answer to when autonomous cars will appear on our roads in massive numbers isn't as simple as one might expect. A large number of rudimentary autonomous features are already in use, and these features will become much more sophisticated. Meanwhile, an avalanche of additional innovation is underway. In fact, auto

industry executives are strikingly similar in their views of the time frame for truly self-driving vehicles:

- General Motors' head of foresight and trends said most industry participants now think that self-driving cars will be on the road by 2020 or sooner.[6]
- Volkswagen's director of digitalization strategy said he expects the first self-driving cars to appear on the market by 2019.[7]
- Ford plans to deliver a high-volume, fully autonomous vehicle for ride sharing in 2021.[8]
- Toyota plans to bring the first models capable of autonomous highway driving to the market by 2020.[9]

> "The successful transformation of the auto industry will require a bridge between Detroit and Silicon Valley. As vehicle systems become more complex, and safety and security remain mission-critical priorities, the role of software or the 'brains' of a car will be more important than ever."
>
> —Marques McCammon

Wind River®, an Intel® company, and its partner Roland Berger, a leading global consultancy, believe that the technological innovation propelling the autonomous car forward will continue to accelerate.

The vast majority of software innovation today comes from small, research-oriented businesses, and these companies do not have the experience or the scale to design, test, and validate production-ready mechanical systems. Similarly, automakers typically do not have the breadth of embedded software development tools or the depth of experience required to deliver production-ready software systems for autonomous vehicles. We anticipate the tipping point for autonomous vehicles will arrive when the auto industry masters the intricacies of radically new software-centric business models. And when that happens, the impact for consumers will be monumental.

CONCLUSION

In this period of profound and rapidly moving change, it is essential for automakers to maintain control of their brand and customers. In this new digital and connected landscape, consumer loyalty is becoming fluid, and software is becoming the means for automakers to differentiate themselves from the competition. Those who cannot become software savvy and quickly adapt to changing trends risk becoming irrelevant. Wind River and its partner Roland Berger can help manufacturers take control of their software destiny and master the intricacies of new software-driven business models.

With broad technology and service offerings based on deep expertise in both the embedded software and automotive industries, Wind River and Roland Berger are collaborating with automakers to begin their software transformation, develop new skill sets, and accelerate innovation for a connected future. To learn more about how Wind River and Roland Berger can help automotive companies, visit www.windriver.com/products/chassis.

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Wind River is a global leader in delivering software for the Internet of Things. The company's technology is found in more than 2 billion devices, backed by world-class professional services and customer support. Wind River delivers the software and expertise that enable the innovation and deployment of safe, secure, and reliable intelligent systems.