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The past five years have been good to the auto industry. Following a cyclical downturn and a series of bankruptcies and harsh restructurings in the wake of the 2008–09 financial crisis, U.S. vehicle sales have been strong, especially for highly profitable trucks and SUVs. Globally, automobiles have grown more attractive than ever, with all kinds of exciting new technologies — impressive powertrain systems, mobile connectivity, advanced driver-assistance systems, maintenance monitoring, and the like — further exciting car buyers.

In the eyes of many in the industry, the future looks equally bright. Oil and gas prices appear likely to remain reasonably low for some time, encouraging big-margin SUV sales. The technology inside autos will continue to grow more sophisticated and affordable.

Automakers feel confident investing large sums of money in developing new features for their cars, particularly advanced safety and navigation options. Many suspect that they can make fully autonomous vehicles (AVs), machines that can drive themselves anywhere, under any traffic and weather conditions, without a human ever having to take the wheel, a reality within a relatively short time, as little as five or 10 years. That, in turn, would open huge new markets, it is hoped, as buyers — large fleets as well as individuals — flock to driverless vehicles and associated services.

There is much truth in the vision of fully autonomous vehicles. Certainly, there will come a time when commuters can relax, eat breakfast, and write emails on the way to work as their robotic taxis transport them on algorithmically chosen routes in perfect safety. But as the recent fatal crash of a Tesla in semi-autonomous mode sadly made clear, it will probably take decades, not years, for this vision to become a common reality.

In the meantime, the industry will have to navigate through a number of difficult challenges, and figure out how to take advantage of a few surprising opportunities. But few industry players are adequately prepared for — or even willing to fully acknowledge — the hurdles they must clear before AVs are able to produce real revenue.

Before prolific AVs become a reality, industry players must make huge investments in meeting tightened mpg and emissions requirements, developing new powertrains, continuing to expand in markets around the world, and developing new vehicles to feed changing transportation needs. It is not clear that all the current competitors will survive. Indeed, there's a strong possibility that the structure of the industry could change, with automakers dis-integrating more of the vehicle's component manufacturing or specializing in particular vehicle categories.

Clearly, in the auto industry, there is a major disconnect between expectations and reality, especially

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with regard to the next five to seven years. AVs will likely take considerably longer to become pervasive than is anticipated, and by that time, the industry will probably look quite different.

Some automakers are already investing hundreds of millions of dollars in the dream of the fully autonomous vehicle, and great strides have been made. Some are also spending hundreds of millions to develop and sell add-on mobile services and applications related to the Internet of Things, but the search thus far for those killer apps and service businesses has come up short.

Predictions that AVs will populate our roads within the next five or 10 years are highly optimistic. Present-day AVs, as advanced as they are, are hardly road-ready. Further advances in technology and affordability are required. AVs still struggle to interact with human-driven vehicles on the road, and they face huge liability, insurance, and even moral concerns that have yet to be resolved. And how will vehicles produced by different companies with incompatible navigation and communications technology interact?

Even once these issues are resolved, it will take another couple of decades to transform our current vehicle population of cars into a robotic fleet. There are, after all, more than 250 million vehicles currently on the road in the U.S. alone, with an average useful life of more than 11 years. And the related vision of rental robocars, owned by the automakers themselves, chartered at will by people seeking short-term transportation, is equally unlikely.

However, one rarely hears mention of the many real, present challenges the industry is up against. Focusing so much attention and so many resources on the captivating prospects of the self-driving world may make for

good reading, marketing, and investor interest. But it is a dangerous distraction for the auto industry.

Facing Reality

Perhaps the most pressing hurdle for the industry is the need to meet increasingly restrictive emissions and fuel-consumption requirements in the Western world. It's easy enough for automakers to build a single car model that meets these requirements. The problem in the U.S. is that an automaker's entire model lineup, including SUVs and light trucks, has to maintain an average level of higher mpg and lower emissions. Making matters more difficult, the average is taken from autos sold, not produced. Automakers are expected to have to improve fuel efficiency by at least 20 percent and as much as 60 percent by 2025, depending on the company and regulations.

This presents a particularly thorny problem for vehicle makers in the U.S., where, thanks to low fuel prices and consumer preferences, they make virtually all their money selling hugely popular trucks and SUVs, which of course bring down those mpg averages. Most customers simply don't want smaller, more efficient cars, and very few companies have been able to make money consistently in this part of the U.S. market. Adding expensive technology to improve fuel efficiency is equally unpalatable: Already, new-vehicle prices are beyond the reach of the average U.S. citizen, according to a recent article in the *New York Times*. It is not at all clear how most automakers will be able to profitably reconcile what government regulators will force them to sell and what customers want to buy.

In response to these pressures, vehicle makers have to invest heavily in technology to squeeze out more fuel

economy and performance. Investments in lighter-weight technologies and powertrains are swelling as never before. The costs of proliferating and advancing engine offerings are staggering, as most automakers are supporting a large array of expensive engine technologies — gasoline, diesel, electric hybrid, plug-in electric, battery electric, and hydrogen fuel cell. Without knowing which path will ultimately win in the context of different federal and state regulatory landscapes, manufacturers are faced with a murky choice of which technologies to bet on, how much to bet, and whether and how to partner with others to spread the costs and risk.

Another challenge is related to the digitization of driver and passenger experiences. Automakers recognize that consumers are attracted to the rapidly progressing connectivity and intelligence in their vehicles — safety features such as blind-spot warnings and automatic pre-collision braking, and convenience and infotainment features such as automated parking assistance and smartphone mirroring on the dashboard. But designing and producing these smart cars and trucks is no easy task, and it poses real risks. The cost of incorporating and managing all the new technology and data is skyrocketing. Further, automakers, given their traditionally hardware-focused organizations and cultures, simply don't have the technology or the software skills to do it themselves. That's why they have been investing in and partnering with technology companies to help design and build AVs. Yet that also presents problems, as automakers' culture, traditionally based on stringent safety requirements and long design cycles, meshes poorly with tech companies' rapid development pace and experimental culture.

At the same time, automakers must scale up geographically, because virtually all the industry's growth is, and will be, in emerging markets. That means satisfying regional differences, including the need for fundamentally cheaper automobiles for emerging economies, a different product design and marketing for these countries, and local manufacturing. These demands compound the requirements for more investment. So the costs and complexities of renewing and expanding product lineups can be expected to grow.

All these demands add to the already enormous and overbearing capital requirements of the industry in general. As the technological demands accumulate, it becomes less feasible to recover the costs of developing a new vehicle and all the powertrain and regional variations it requires. As automakers create ever more vehicle

models and variants in attempts to achieve more volume on which to spread their investments, they further increase the total capital needed.

These pressures will bring into stark relief the industry's notoriously weak capital efficiency. Its historical return on invested capital has generally been below the cost of that capital, despite the restructuring that followed the 2008–09 financial crisis, and significantly lower than that of virtually every other major industry globally. On top of that, the industry's margins are so closely tied to the number of vehicles it sells that it makes the industry's profitability highly cyclical.

Taken together, this bodes ill for an industry facing the massive investments required to overcome the challenges coming up in the next five to seven years. An economic downturn in this time frame, which is highly plausible, would only pile on more pressure. Only players with sufficient scale and shrewd technology and investment strategies will prevail to confront the next set of obstacles posed by the fully autonomous auto world. The question is, what can an automaker do to meet these more imminent challenges?

The Way Forward

As serious, and even overwhelming, as the obstacles faced by the auto industry today appear to be, companies that position themselves properly will prosper. To do so, however, they must take the first step of carefully separating what needs to be accomplished within the next five to seven years from the investments needed for a longer-term future of self-driving cars.

Robotic vehicles and noncore service businesses cannot offer a near-term solution for all the industry's challenges. Companies along the automotive value chain must realistically decide how much of their precious management attention and financial capital they will deploy on the longer-term speculative opportunities and how much on the more immediate challenges. They must successfully traverse the minefield just ahead in order to be able to participate in the big battles of the fully autonomous world.

The second step is for companies to clearly decide what their strength is — for example, building large trucks and SUVs, powertrains, or some other technology integration — so that they put their resources into the scale and capabilities needed to thrive in their chosen area. They should do this while keeping in mind that not every automaker will survive in its current form, nor can they all hope to gain the scale and breadth

of the largest players.

Because of this, it is wise to assume that the auto industry will undergo a substantial restructuring between now and 2025. This restructuring will force most automakers to redefine themselves, not by their past product lines or where they do business, but by what they are particularly good at, what their most distinctive capabilities are, where they have the appropriate scale to compete, and thus where they fit into the industry's overall value chain.

For automakers, this shift will likely entail breaking up industry verticals and dis-integrating large segments of the industry in response to the overwhelming impending capital requirements. So suppliers may achieve greater scale by taking on more of what auto manufacturers outsource for multiple carmaker customers, or new suppliers may leverage scale from outside the auto industry.

One potential course for an automaker trying to focus its limited capital on its core offerings is to source some vehicle segments from a joint venture, a competitor, or even a consortium of auto companies. An automaker with insufficient profitable small cars to meet regulatory emission and fuel economy mandates might find it makes the most strategic sense to establish a joint venture with another company to provide them, or to just buy them from an independent small-car specialist.

Outsourcing some or even all powertrains, which are an increasingly capital-intensive and risky part of the business, is another way to conserve scarce resources. This, in turn, would create opportunities for a merchant powertrain supplier to achieve greater scale, resiliency, and viability. Perhaps the small-car joint ventures and specialists will source all their powertrains from the same supplier or two.

Relying more heavily on suppliers for other expensive, high-technology subsystems — infotainment, holistic vehicle interiors, or advanced driver-assistance packages — is another avenue. For instance, a consumer electronics company, leveraging technology, operations, brand, and customer pull from its much larger scale, might provide an entire infotainment and customer-interface system for an automobile more effectively than the existing supply chain of an automaker.

Regardless of what form they take, partnerships, alliances, and joint ventures are likely to become much more common. As these types of arrangements expand, the old lines of distinction between automakers and suppliers, auto industry players and technology compa-

nies, and those that were previously competitors could permanently change. Some branded auto manufacturers may evolve from full-line manufacturers to focused players or even branded suppliers of a particular type of powertrain or interior, most of their products sold or offered in onetime competitors' vehicles. Joint ventures with companies outside the auto industry — such as technology companies with digital expertise — will also increase. Alliances like these, of course, have occurred in the past, with decidedly mixed results. A distinctive capability for many of the winners in the industry will certainly be learning how to adapt their organization and culture to incorporate advanced digital technology. A restructuring of the industry is inevitably on the horizon, so rather than being swallowed up whole or picked apart by larger companies interested only in their most obvious strengths, these companies should already be focusing on those strengths and paring away anything that distracts from their chosen way to play. They have to judiciously select what technologies and investments they should and can afford to make, and deploy their limited resources accordingly. They should be pursuing creative and aggressive new strategies of vertical dis-integration and partnerships that can make up for insufficient scale.

Overinvesting in the pursuit of fully autonomous solutions and noncore businesses runs the great risk of focusing companies' precious attention and resources away from the tall tasks that have to be mastered well before the AV dream has a chance of becoming reality.

No matter what future we can imagine for the auto industry, it will probably always be plagued with cyclicity, high capital costs, changing consumer demand, and regulation. That's just the nature of a business in which technology matters more and more, government requirements get tighter and tighter, and ever more companies are chasing new markets around the world. But companies that understand this, and can focus over the next five to seven years on profitably designing, manufacturing, and marketing the kinds of vehicles or vehicle systems they excel at, while establishing partnerships for the rest, will be in the best position to survive and thrive. Those that put too much energy, money, and other resources into a more distant, more unpredictable future will struggle to meet their much more pressing challenges. It will be a matter of survival of the fittest, and every auto company still has the opportunity to optimally position itself for the changes ahead +

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