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STRATEGY IN THE AUTONOMOUS VEHICLE SEGMENT

THE CURRENT STATE OF SELF-DRIVING CARS

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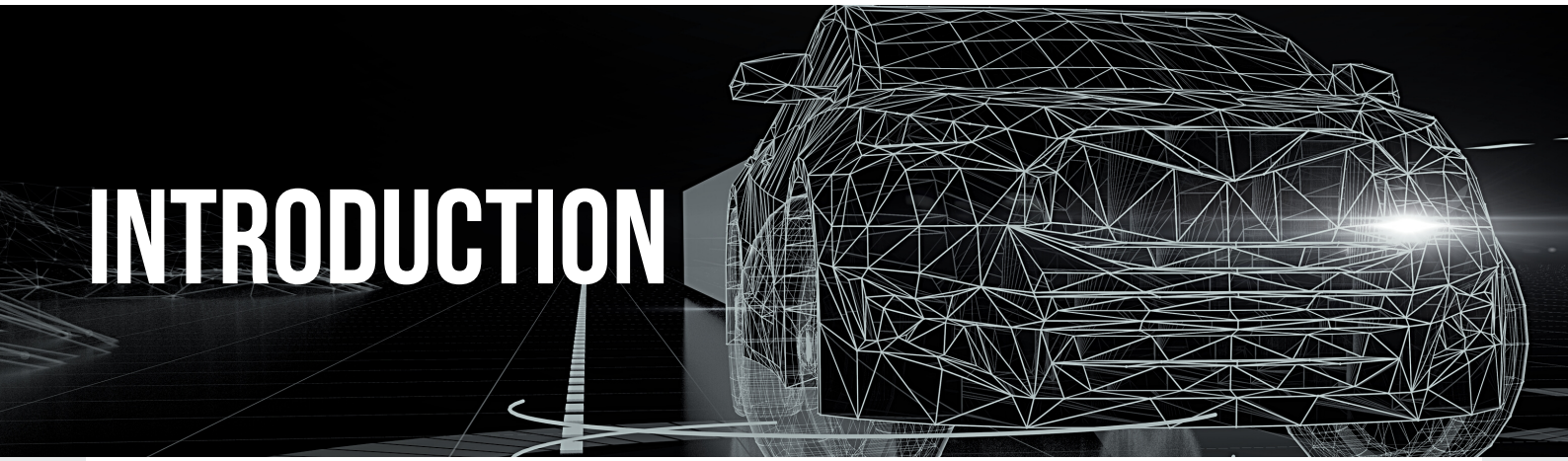

INTRODUCTION

Fifty years ago, the notion that your car would run on electricity and be able to drive, park, and charge itself seemed like an idea straight from a Philip K. Dick novel. In 2019, leaders in the ride-sharing industry began large-scale testing of their own autonomous vehicles that could pick up, drive, and drop off passengers without a human ever touching the car's controls.

The development of autonomous electric vehicles represents the apex of the revolution currently occurring in the automotive industry. The industry is marching, slowly but inexorably, towards a world in which cars may no longer need humans behind the steering wheel. This is known as Level 5 automation: where a car does not need a driver in any conditions and may not even have a steering wheel or pedals [1]. The nirvana state of an autonomous network of vehicles that drive, park, and recharge themselves would radically change the concepts of vehicle ownership and personal mobility. The only question is: how do companies build those vehicles?

Tesla's Model S was introduced in 2012 and represented the beginning of mainstream adoption of electric vehicles ("EVs"). Although it wasn't the first EV sold in the United States—General Motors released the EV1 in 1996—it represented the start of a new era. The replacement of the internal combustion engine with an electric motor meant that vehicles could be controlled by software much more easily, and it meant the introduction of autonomous vehicles ("AVs") would be inevitable. Accompanying the release of the Model S, Tesla announced a future in which their cars would become autonomous.

It is difficult to underestimate the impact that AVs will have on the automotive sector, and on personal mobility writ large. Technologies such as RADAR and LiDAR, once the domain of aerospace and defense industries, have been adopted by auto companies, while hundreds of new startups have been born in an effort to realize the promise of pollution-free, autonomous mobility. The automotive industry has been through revolutions before, but not since the invention of the taxicab have the spillover effects offered such a profound impact on mobility. Similarly, the autonomous vehicle revolution is also the first time that the automotive industry has been able to partner with the technology industry to take a platform approach.

STRATEGIC DECISIONS

In order to take part in the autonomous vehicle revolution, companies must undertake a series of strategic decisions to understand which markets to enter and which roles to play. Yet the autonomous revolution is so nascent, and its future so far from clear, that companies must make decisions in a period of enormous uncertainty. Companies have already begun to make these decisions, some of which seem irreversible: Tesla has already vertically integrated manufacturing and self-driving technology, and built a network of charging stations in order to deliver its own technology stack and control the entire customer experience. But other manufacturers, such as Toyota, have a strategy that seems much less certain.

The question at the core of the autonomous vehicle revolution is: what is the best path forward for a company to successfully compete in the AV market? Ultimately, that decision needs to be made by identifying and integrating deep technical expertise from several domains — computer vision, navigation, driving, and manufacturing — into a complete package. This integration needs to occur quickly, in a crowded marketplace, at a price that shareholders will accept, and in a sphere of ever-changing regulation. These decisions are not easily made.

TECHNOLOGY STACKS

The capabilities of AVs are graded according to 6 levels. Most older cars on the road today are Level 0, where there is no automation and the driver maintains complete control. More modern cars are Level 1 or Level 2, where features like anti-lock brakes, cruise control, and stability control assist the driver in certain circumstances. A good example of Level 3 technology is adaptive cruise control, where the car can adjust its speed and position in a lane in a relatively simple environment, such as an individual highway lane. Tesla's Autopilot and Cadillac's Super Cruise can be classified as Level 4, where the car can drive itself under certain circumstances but driver inputs may still be required, and the car still has traditional controls.

In order to operate at Level 4 or 5, an autonomous vehicle requires a variety of technologies, often referred to as a "stack", which are both commoditized and specialized. Broadly speaking, an autonomous vehicle's stack needs the following subsystems in order to operate: a vision system (e.g. cameras, RADAR, or LiDAR) to perceive the world, a processing system (e.g. CPUs or GPUs) to understand what it perceives, a navigation system (e.g. GPS, mapping) to steer through the world, and an automotive interface system to drive the car's controls. And, of course, you need the car itself.

The proliferation of electric vehicles, as well as the development and introduction of truly autonomous vehicles, has led to a radical reshaping of the automotive and personal mobility landscapes. Not only have we seen a rush of new entrants into this emerging market, but we have seen collisions of players in existing markets that would, at first glance, seem hard to imagine. Ride-sharing companies have partnered with auto manufacturers, auto manufacturers have tried to become software companies, software companies have tried to become car companies, and more. Although the technologies and business models are not yet fully proven, companies are spending billions of dollars in a fight to survive in a market that is not yet fully defined. In this paper, I will attempt to understand how they are positioned, what they require for success, and if there is a better approach.

GO-TO-MARKET STRATEGIES

Some existing go-to-market approaches make inherent sense. For example, many traditional automotive parts suppliers, known as OEMs, have adjusted to the new normal by developing extremely high-tech parts used by AV manufacturers, such as German automotive parts supplier Continental building RADAR units for Tesla's Model 3 [2]. Brand new startups have also entered the OEM picture, such as U.S. startup Luminar, partnering with Volvo to develop a LiDAR system for its vehicles [3, 4]. But for the most part, the business of OEMs has remained largely unchanged. Although adoption of new AV technologies has introduced new suppliers into the ecosystem, the industry itself remains the same — their core business is selling auto parts in large volumes and at low margins to traditional automakers.

When it comes to the automakers themselves, the go-to-market challenges are profound. Traditional car manufacturers, such as the "Big Four" in the United States (Ford, General Motors, Fiat Chrysler, and Toyota) have been forced to grapple with a difficult choice: should they develop their own purpose-built autonomous vehicles (so-called "robotaxis"), or should they add autonomous capability to standard electric vehicles? In order to develop either of these types of vehicles, should they partner with an AV startup or should they go it alone? So far, there does not seem to be a unanimous answer.

PARTNERSHIP STRATEGIES

MANUFACTURERS

The difficulty and cost of creating an autonomous vehicle—even if built on top of an existing electric vehicle—are difficult to overstate. Car factories require a multibillion-dollar investment before the car is even built [5]. To develop its own autonomous vehicles, Dearborn-based Ford has partnered with Argo AI and given the startup a $1B investment [6]; rival car maker Volkswagen has also invested $2.6B in Argo [7]. Instead of simply using Argo as a contractor to solve a fixed set of problems, Ford will combine their own in-house software group with hardware expertise from Argo as part of a single organization.

Meanwhile in Detroit, General Motors acquired Y Combinator-backed startup Cruise in 2016. Since then, San Francisco-based Cruise has seen billion-dollar investments from Softbank, General Motors, and even rival automaker Honda [8, 9]. GM is focusing on bringing a robotaxi product to market through its investment in Cruise, but has chosen a unique strategy: instead of selling its vehicle (the “Cruise Origin”) directly to customers, GM plans to offer the vehicle as part of its own AV fleet [10], putting the company in direct competition with Waymo.

Plano-based Toyota has opted to partner with Sino-American startup Pony.ai, to the tune of $400M. Pony is touting its experience with autonomous vehicles for ride-hailing startups, and Toyota has released little other information on its plans for Pony [11]. Despite a market capitalization of $168B, Toyota’s autonomous vehicle strategy remains virtually opaque.

For Fremont-based manufacturer Tesla, the answer has been to develop their own electric vehicles while also developing their own autonomous driving capability, adding the latter to the former incrementally via a series of software and hardware updates. Tesla has recently gone so far as to design and build its own CPUs [12], whereas most traditional automakers are partnering with GPU maker NVIDIA for their computational needs [13]. Tesla has also introduced its own dealer network and charging station network, making it by far the most vertically integrated of all the manufacturers. The stock market has rewarded Tesla's forward thinking: although it sells far fewer cars, Tesla has a larger market capitalization than Ford, GM, or Fiat Chrysler.

RIDE-SHARING COMPANIES

Ride-sharing companies have taken a different approach. Because drivers are the largest single source of costs, companies hope to be able to scale up and add driverless robotaxis, saving costs in the process. Only the largest two ride-sharing companies, Uber and Lyft, have made progress with autonomous vehicle rollouts in the United States. Uber created its Advanced Technology Group, and bought off-the-shelf Volvo XC90 SUVs as a base to develop its own AV [14]. Uber later partnered with Volvo to officially co-develop self-driving capabilities around the same XC90 platform as part of a joint engineering agreement [15]. Uber would use some, but not all, of Volvo's hardware; Uber alone would design its software. This system's failings would come to tragic light in 2018, with the death of Elaine Herzberg, a pedestrian who was struck and killed by a self-driving Uber in Tempe, Arizona.

Archrival Lyft has its own Autonomous Group working on AV deployment. Lyft has taken a different approach to partnership [17], working with OEM giant Aptiv (formerly Delphi Automotive Systems) as well as Waymo, part of the Alphabet family. Both Uber and Lyft are working on developing self-driving stacks to control cars but have no plans to manufacture cars themselves. Lyft is working with Ford and Chrysler on the Fusion and Pacifica, respectively, as autonomous vehicle testbeds.

NEWCOMERS

Finally, there are the newcomers: companies who have entered AV market but have skipped manufacturing traditional vehicles. Google created its self-driving car project in 2009 and renamed the project Waymo when it spun the project out under Google parent company Alphabet. Waymo operates both modified passenger cars for testing as well as specialized vehicles for its autonomous fleet. But apart from collecting enormous amounts of data – data is Google's currency, after all – Waymo has had the least commercial impact in the market so far. The Mountain View organization has partnered with German assembler Magna to convert passenger cars from Jaguar and Chrysler into AVs, although little is known about the program.

Most surprisingly of all is Apple's enigmatic developments in the space. The company has remained tight-lipped on Project Titan, which has been described as both a mechanism to modify existing cars, as well as the development of an all-new, purpose-built driverless car. Very little information about the project exists; the most recent industry gossip suggests that Apple has pivoted from making cars to simply making autonomous vehicle software [18].

As we have seen, the two industries most impacted by the rise of autonomous vehicles are automobile manufacturers (such as GM, Ford, Fiat Chrysler, Tesla, and Toyota) and ride-sharing companies (such as Uber and Lyft). With the exception of Tesla, no one in the market is trying to build an AV stack in-house. Tesla leads the way in self-driving technologies today, but it has just a fraction of the manufacturing experience and capacity of the Big Four automotive companies. Interestingly, Tesla does not take the most high-tech approach in every single aspect; the company eschews advanced LiDAR in favor of simpler technologies, and CEO Elon Musk has gone so far to say that "anyone relying on LiDAR is doomed" [19]. This choice may ultimately come back to haunt them, as it may inhibit Tesla's ability to produce cars that can drive automatically in all conditions (i.e., SAE Level 5) [20] — particularly conditions which may require a clarity of vision that only LiDAR can provide.

Any viable, market-leading solution is going to require a combination of industry partnership and technological convergence in order to be successful. Unlike problems in other high-tech industries, the AV problem cannot be solved by auto manufacturers simply sharing costs; instead, automakers need to find highly competent partners with deep expertise in a variety of different domains. The depth of expertise required means that it is extremely difficult to pick winners and losers, as a strategic or operational advantage in one domain does not guarantee overall victory in the market. General Motors sold 7.7 million cars in 2019 compared to Tesla's 400,000, but GM's bureaucracy and penchant for indecision is legendary. While Tesla may produce vehicles with a defect rate that would make a GM manager blush, no one can accuse the company of being slow to react or adjust. As Tesla has found with its "production hell" [21], a bad choice may not mean total failure, but it may come at a significant cost.

A THREE-PHASED APPROACH

In my opinion, the ultimate approach for companies wishing to sell AVs to the masses involves a three-phased approach:

1. In the short-term, an automaker should partner with relevant experts in vision, navigation, and controls. This includes both software and hardware startups.
2. In the medium-term, that automaker should ramp up AV production in its own factories. As the market matures, expect OEMs to produce AV components at scale.
3. In the long-term the automaker should produce, or help produce, a modularized chassis that can be adapted for use as a robotaxi. At this point, business models may begin to diverge.

What complicates the execution of such an approach is the inability, or perhaps unwillingness, for companies to acknowledge their desired role in the market. For example, Google has invested more than $1B over the course of a decade in Waymo, yet does not seem to have its heart set on actually building an AV fleet. Rather, the company seems to be flexing its intellectual prowess, all as part of its ever-expanding search for customer data to be used in advertising. Ford had plans for an AV fleet, but recently pushed that program back to 2022 at the earliest [22]. Toyota's partnership with Pony.ai is vaguely focused on "mobility services"; the Japanese automaker seems unwilling (or unable) to disclose its true market ambitions. General Motors seems to have set aside the desire to build regular AVs, and is instead focused (through Cruise) on just creating a robotaxi fleet. Only Tesla appears to be trying to do it all, with the mercurial company simultaneously pursuing AVs for the consumer market as well as pronouncing that it will have one million robotaxis on the road by the end of 2020 [23].

CONCLUSION

An idea once thought impossible, the autonomous vehicle industry is on the verge of entering the mainstream. In certain U.S. cities, it is possible to ride in a robotaxi where no human ever touches the controls. Companies like Cadillac and Tesla are selling vehicles with Level 3 self-driving technology, where the cars drive themselves with very little human interaction. Yet considerable obstacles remain, as evidenced by the fact that automakers have consistently missed their targets for features, release dates, and production schedules. Similarly, a national robotaxi ride-sharing network seems years away, while Uber and Lyft are hemorrhaging money.

In many ways, automakers' hardest challenge is ahead of them: how to transition from the second phase to the third phase. They will have to decide whether or not to enter the robotaxi market, and it is even concievable that, in the following decade, they will have to decide whether or not to exit the traditional passenger car market. Ride-sharing companies will need to work on increasing the scale of their networks without running out of cash in the process. They will also need to ensure some type of competitive advantage in order to stay relevant: if GM or Tesla can build their own fleets of robotaxis, do they need (or want) a middleman in the platform to match riders with cars?

As Bill Gates famously said, "We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten." This may be the decade where the promise of an autonomous vehicle revolution becomes a reality.

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