

EDGE > **EVOLUTION** | **DISRUPTION** | **GROWTH** | **EMERGING THEMES**

Autonomous Vehicles

ACTIVE FUNDAMENTAL EQUITY | COUNTERPOINT GLOBAL | INVESTMENT INSIGHT | 2019

WELCOME TO THE EDGE.

Morgan Stanley Investment Management's Counterpoint Global publishes its proprietary views on a big idea that has the potential to trigger far-reaching consequences—ideas such as autonomous vehicles, artificial intelligence, robotics and bioengineering.

Counterpoint Global's long-term ownership mindset emphasizes perspective, insight and thinking across categories, while our investment process focuses on identifying unique companies with sustainable competitive advantages. Through The EDGE, we share our framework for thinking about change and our process for recognizing patterns that may drastically alter the investment landscape over the longer term.

This work complements our team's more traditional, fundamental research to create a framework for long-term investing that is grounded in intellectual curiosity and flexibility, perspective, self-awareness and partnership.

Autonomous vehicles use a suite of sensors, actuators and a central computer to "perceive" the environment and automate the driving process, thereby enabling the vehicles to drive themselves without human involvement. Autonomous vehicles could change not only the way we move from point A to point B, but also how we live our lives.

For investors, the rise of autonomous vehicles has the potential to impact industries as far afield as health care, insurance, internet and infrastructure. For instance, one of the key drivers of autonomous vehicle adoption is improved safety. Over 90% of all traffic accidents are caused by human error.¹ With 40,000 U.S. traffic fatalities and 1.2 million globally every year,² removing humans from the driving equation could significantly reduce accidents—potentially benefiting both vehicle-related injury and mortality while reducing health care spending and the potential revenue opportunity for property and casualty insurance. ▶

¹ "The Relative Frequency of Unsafe Driving Acts (Background)," National Highway Traffic Safety Administration, August 15, 2017.

² "2016 Was the Deadliest Year on American Roads in Nearly a Decade," Fortune, February 15, 2017. "Road traffic injuries," World Health Organization, August 16, 2017.





► Autonomous driving is a specialized application of machine learning. The sheer complexity of accounting for all the potential situations that an autonomous vehicle might encounter prevents a more traditional approach of programmers writing specific code to solve for autonomy. Instead, sensors like LIDARs (light detection and ranging, which use lasers to map their surroundings in 3D), radars, GPS and cameras collect data about the environment around the car. This sensor data is fed into specialized deep neural networks running algorithms that detect patterns among all the data and convert it into usable insights (i.e., perception). Placing a variety of sensors at multiple locations around the car that each have unique strengths and weaknesses and excel under different environmental conditions improves the vehicle's perception. While not all data is created equal, in general the more data you have, the better picture you can paint of your surroundings. For instance, a deep neural network for vehicle detection would begin to recognize, after seeing many examples, that when the sensors have certain readings it signifies not only that there is a vehicle ahead, but also can determine the distance between the two vehicles. Engineers develop separate deep neural networks using the sensor data to perceive everything from pedestrians to lanes to other vehicles. On top of these deep neural networks, applications are written that enable the car to function autonomously. For instance, advanced emergency braking is an application

that enables the vehicle to brake autonomously if the deep neural network detects a vehicle ahead of itself stopping suddenly. These various applications are stitched together in the vehicle's central computer, which makes the ultimate determination which actions to take.

The coming of autonomous vehicles could change our conception of personal transportation. Today, the vast majority of people travel in vehicles they own and operate themselves. In the U.S., owning and operating a vehicle is typically the second-largest expense for a household after shelter, costing on average \$8,700 per year.³ Despite being such a large expense, the typical car is only used 5% of the time.⁴ In the future, consumers might prefer to trade the expense and hassle of auto ownership for ridesharing (that is, being chauffeured in a fully autonomous vehicle). By removing the driver from the equation—the single-largest expense in a rideshare—and hypothetically boosting the utilization rates of vehicles by a factor of 10 times, fully autonomous vehicles could promise to dramatically lower the cost of ride sharing and boost its addressable market. In addition to potentially saving money, the consumer could now repurpose his/her time. The average American spends 55 minutes per day commuting.⁵ That time spent riding versus driving could be used to catch up on sleep, work, or use of mobile media, thereby expanding the addressable markets for those services as well. Autonomous vehicles could also

change the way cities are structured. Typically, there are three parking spaces for every car—at home, work and play. In the future, with higher vehicle utilization rates and the ability to park remotely, the need for parking, especially in the central core of cities, could be greatly reduced.

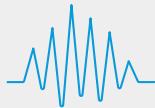
The biggest challenge facing the adoption of autonomous vehicles today is achieving the requisite level of accuracy required to drive safely on public roads in mixed traffic. The decision-making and driving capability of autonomous vehicles need to be practically flawless. Ensuring this high standard is met requires training the autonomous vehicle with massive amounts of data that takes into account any possible situation it may encounter and extensive safety testing to validate that the autonomous vehicle performs as expected at all times.

Once the safety of the systems is established, another large hurdle to adoption will be the regulatory environment. Governments and regulatory bodies need to develop frameworks to permit the operation of autonomous vehicles on public streets and highways. Currently, the regulatory process in many jurisdictions is unclear and/or undeveloped. In addition, legal questions need to be addressed, such as whether accident liability lies with the autonomous vehicle's owner or the manufacturer that developed the systems that enabled it. The U.S., with its large number of trial lawyers and class action suits, may see autonomous vehicle sales delayed versus other geographies until the safety

³ "Annual Cost to Own and Operate a Vehicle Falls to \$8,698, Finds AAA," AAA, August 16, 2017.

⁴ "Today's Cars Are Parked 95% of the Time," Fortune, March 13, 2016.

⁵ "National Household Travel Survey Daily Travel Quick Facts," United States Department of Transportation, August 16, 2017.



OTHER DISRUPTORS

Other themes the team is currently researching include

- Blockchain
- Virtual/Augmented Reality
- Machine Learning

and reliability of autonomous vehicles are more established in other markets.

Despite the potential roadblocks to adoption, this technology is rapidly progressing from the realm of science fiction to reality. In the next five years, we should see commercial launches of autonomous vehicles by more than one OEM (original equipment manufacturer). The initial rollouts are likely to be selective, with cars released into the most optimal markets and environments. For instance, the first

autonomous vehicles will likely be deployed in markets with clearly defined regulatory frameworks and liability definitions. Also, markets with favorable climates, meaning little or no challenging weather like snow and fog, will likely see autonomous vehicles before those that have frequent inclement weather. While there will be bumps on the road to mass adoption, it is not outside the realm of possibility that a child born today may never need a driver's license.

Risk Considerations

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Counterpoint Global

Counterpoint Global Team

DENNIS LYNCH, Head of Counterpoint Global

New York

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JASON YEUNG	Health Care	22	17	15
ARMISTEAD NASH	Business Services, Software	19	17	15
DAVID COHEN	Consumer	31	26	20
ALEX NORTON	Consumer, Industrials, Technology (ex Software)	24	19	19
THOMAS KAMEI	Internet, ESG	7	7	7
MANAS GAUTAM	Generalist	7	4	4
ANNE EDELSTEIN	Health Care	8	1	1
ABHIK KUMAR	Business Services, Software	10	<1	<1

DISRUPTIVE CHANGE RESEARCH

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SASHA COHEN	Big Ideas, Emerging Themes	2	2	2

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ROBERT ROSS	Portfolio Administrator	27	22	2

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- 2 Portfolio Specialists

"Investor" refers to an analyst or portfolio manager of Counterpoint Global

Team members may change without notice from time to time. Years of Experience listed above refers to Industry Experience. Years of Experience, Years with Firm and Years with Team are as of June 2019

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