

Investing in the Automobile of the Future

Artisan Non-U.S. Small-Mid Growth Strategy

PORTFOLIO MANAGER
Viewpoints

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The automobile industry is experiencing massive change as a result of increased demand for electric and hybrid cars that require batteries and the evolution of autonomous driving features that rely on connectivity. We believe these structural shifts are enduring and offer potential opportunities for long-term oriented investors, such as ourselves. However, investors will need to be discerning as both winners and losers will emerge.

Consider the first shift: The transition from internal combustion engines to electric vehicles (EVs) is being driven by climate change-related regulations to reduce carbon-dioxide emissions and decrease air pollution. It's estimated that 23% of total CO₂ emissions from fuel combustion are transportation related. Consumer preferences should also contribute to the shift to EVs, given they are cheaper to fuel and maintain. The pace of EV adoption will be influenced as well by the rate at which battery prices continue to decline—lithium-ion battery prices have fallen roughly 80% since 2010 and are projected to fall a further 73% by 2030—in addition to the reduction in battery recharging times and the nascent build-out of charging infrastructure in much of the world. We're still very much in the early innings of this transition, in our estimation. EVs accounted for only 1% of the global auto market in 2017, but EV sales are expected to grow at an annual rate of 33% through 2022.

Another shift is the degree to which cars are becoming increasingly connected. Approximately one in three vehicles sold in 2015 already had some degree of connectivity. Bluetooth technology that enables hands-free phone calls was one of the earliest examples of connectivity in the automobile. In the same way, infotainment services for streaming navigation information, traffic information and music have become standard features. Advanced driver assistance systems (ADAS), such as blind spot monitoring and surround-view cameras, were more recent innovations. We see the growth in ADAS content in the car as part of the evolution toward increasing levels of vehicle automation. Eventually, we expect mass adoption of fully autonomous or self-driving vehicles, but we see this occurring over a longer timeframe than the shift toward EVs.

The next-generation automobile is one of the more prominent themes in which we are invested. As with other themes, we try to identify businesses that will serve as high value-added bottlenecks in their industries. We choose to avoid parts of the industry value chain that we believe will be commoditized or highly capital intensive, such as battery suppliers. Instead, we are more focused on the increased semiconductor content of the car and, in particular, the role of next-generation power semiconductor technologies. Handling tasks such as fast charging or controlling electric current to the main motor, these devices are critical in enabling appropriate standards of safety, durability, power and range for the car.

Not only is the number of power semiconductors within a car structurally increasing, but the underlying material science is also shifting. Traditional silicon-based semiconductors are reaching their physical limitations in terms of ability to efficiently handle high voltages. Instead, compound semiconductor materials such as silicon carbide (SiC) are becoming crucial. SiC, one of the hardest materials on the planet, enables semiconductors to operate efficiently across a much wider range of voltages and temperatures, meaningfully extending battery efficiency while reducing the system's weight.

Only a handful of companies have the intellectual property and process know-how to manufacture the silicon carbide wafers from which the next generation of power semiconductors are produced. Rohm, a Japanese company, is where we first identified the critical role of silicon carbide-based power semiconductor



Rezo Kanovich
Portfolio Manager

20 Years Investment
Experience



technology. Our approach to idea generation is to triangulate—geographically and within industry value chains. In analyzing the competitive landscape across geographies, we also got to know Cree, a US-based company. We believe the substantial lead Rohm and Cree have within the SiC industry positions them well to benefit from the secular trend toward EVs.

Next, we thought further about the broad adoption of these compound semiconductors and what it would mean for the industry. That analysis led us to a German company called Aixtron that has a dominant market position in making metal-organic chemical vapor deposition (MOCVD) equipment critical in manufacturing of compound semiconductors. We believe Aixtron will benefit tremendously as we see an explosion of growth in the number of use cases for compound semiconductors.

Additionally, we looked at the increased software content in the future automobile—in particular, the security aspects of automotive software. Connectivity, which is a prerequisite for autonomous driving, introduces the threat of cyberattacks. We have a position in a company called BlackBerry, which is commonly known for its legacy in telephone handsets. At the direction of a new CEO, the company applied the underlying IP that made these handsets so secure to other end-market applications. Specifically, BlackBerry has a software business called QNX that is a world-leading operating system with the necessary security features for a connected car. QNX is being used in ~120 million cars today and has a significant opportunity to increase its content sold per car. Although this space is competitive, BlackBerry has a lead in the race for the operating system of the connected car.

In conclusion, the automobile is undergoing a fundamental re-architecture where it is becoming electrified, connected and, in the long-run, autonomous. As these structural shifts play out, we anticipate significant change in the relationships between auto manufacturers and suppliers as well as in the economics of the distribution chains. Therefore, we believe it's critical to understand how value will accrue to select parts of the industry. Those suppliers providing the most critical parts and differentiated solutions should be the biggest beneficiaries, in our view. Like smartphones, we believe the future automobile will be a software- and semiconductor-defined product.

Exhibit: Potential winners of the next-generation automobile

	Key Product(s)	Description and Investment Thesis
Rohm	Power semiconductors	Rohm is a Japan-based semiconductor company that has specialized knowledge in making silicon carbide-based power semiconductors. Additionally, Rohm is one of the few companies that can make the silicon carbide wafers needed for the chips.
Cree	Power semiconductors	Cree's Wolfspeed semiconductor business specializes in producing semiconductors from silicon carbide, which exhibits greater physical capabilities, and is superior to silicon when it comes to power management in batteries.
Aixtron	Compound semiconductor manufacturing equipment	Aixtron is the global leader in MOCVD machines, which enable a critical step in the manufacturing process for compound semiconductors. Today, an increasingly critical use case for MOCVD machines is enabling the manufacturing of VCSELs (Vertical Cavity Surface Emitting Laser) a key component in LiDAR systems, which will be critical for assisted / autonomous driving.
Blackberry	Security software	Blackberry's QNX software platform—built around Blackberry's highly-secure operating system—allows a "connected car's" software stack to be built in a highly containerized fashion and therefore meet the highest safety standards.

Artisan Non-U.S. Small-Mid Growth Strategy

The investment team employs a fundamental stock selection process focused on identifying long-term growth opportunities to build a portfolio of primarily non-U. S. small- and mid-cap growth companies. The team generally seeks long-term investments in high-quality businesses exposed to structural growth themes that can be acquired at sensible valuations in contrarian fashion and are led by excellent management teams.

Management

Rezo Kanovich is a managing director of Artisan Partners and the sole portfolio manager for the Artisan Non-U.S. Small-Mid Growth Strategy.

Prior to joining Artisan Partners in October 2018, Mr. Kanovich was a portfolio manager for OppenheimerFunds, where he managed the International Small-Mid Cap strategy from January 2012 to 2018. Before that, Mr. Kanovich worked as an analyst with Boston Biomedical Consultants, an investment banker with the Lehman Brothers mergers & acquisitions team and as a consultant at PricewaterhouseCoopers. Mr. Kanovich holds a bachelor's and master's degree in international economics and finance from Brandeis University and a master's degree in business administration, dual concentration in finance and health care systems, from the Wharton School, University of Pennsylvania.

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International investments involve special risks, including currency fluctuation, lower liquidity, different accounting methods and economic and political systems, and higher transaction costs. These risks typically are greater in emerging markets. Securities of small- and medium-sized companies tend to have a shorter history of operations, be more volatile and less liquid and may have underperformed securities of large companies during some periods. Growth securities may underperform other asset types during a given period. Investments will rise and fall with market fluctuations and investor capital is at risk. Investors investing in strategies denominated in non-local currency should be aware of the risk of currency exchange fluctuations that may cause a loss of principal. These risks, among others, are further described in Artisan Partners' Form ADV, which is available upon request.

Portfolio Manager: Artisan Non-U.S. Small-Mid Growth Strategy—Rezo Kanovich

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Strategy information contained herein relates to a representative account managed within the investment composite. It is intended to provide a general illustration of the investment strategy and considerations used by Artisan Partners in managing the strategy.

For the purpose of determining the portfolio's holdings, securities of the same issuer are aggregated to determine the weight in the Strategy. The holdings mentioned above comprised the following percentages of a representative account within the Composite's total net assets as of 30 Jun 2019: Rohm Co Ltd 1.1%; Cree Inc 1.6%; AIXTRON SE 0.6%; BlackBerry Ltd 0.5%. Portfolio holdings are subject to change without notice and are not intended as recommendations of individual securities.

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