# STRATEGIC FORESIGHT: Manufacturing and Automotive Technology Quarterly

The Black Box Institute
2015 Q4

# PREFACE

The manufacturing sector was expected to be one of the bright spots in the Canadian economy in 2015, driven by a weak Canadian dollar and a strong US economy. But the sector never quite lived up to that promise in 2015. Even excluding petroleum products, manufacturing sales decreased 1% year-over-year in the first three quarters of 2015. This is the spill-over of the plunge in energy prices to other parts of the economy because Canada has a lot of manufacturers supplying the energy sector.

The automotive sector exports jumped 13% year-over-year in the first three quarters of 2015, but on a volume basis, they decreased 1%, parallel to manufacturing sales. Canada's share of US auto imports has been substantially eroded over the past decade, displaced by lower-cost competitors from Mexico and China, and Canada's manufacturing capacity took a serious hit in the recession.

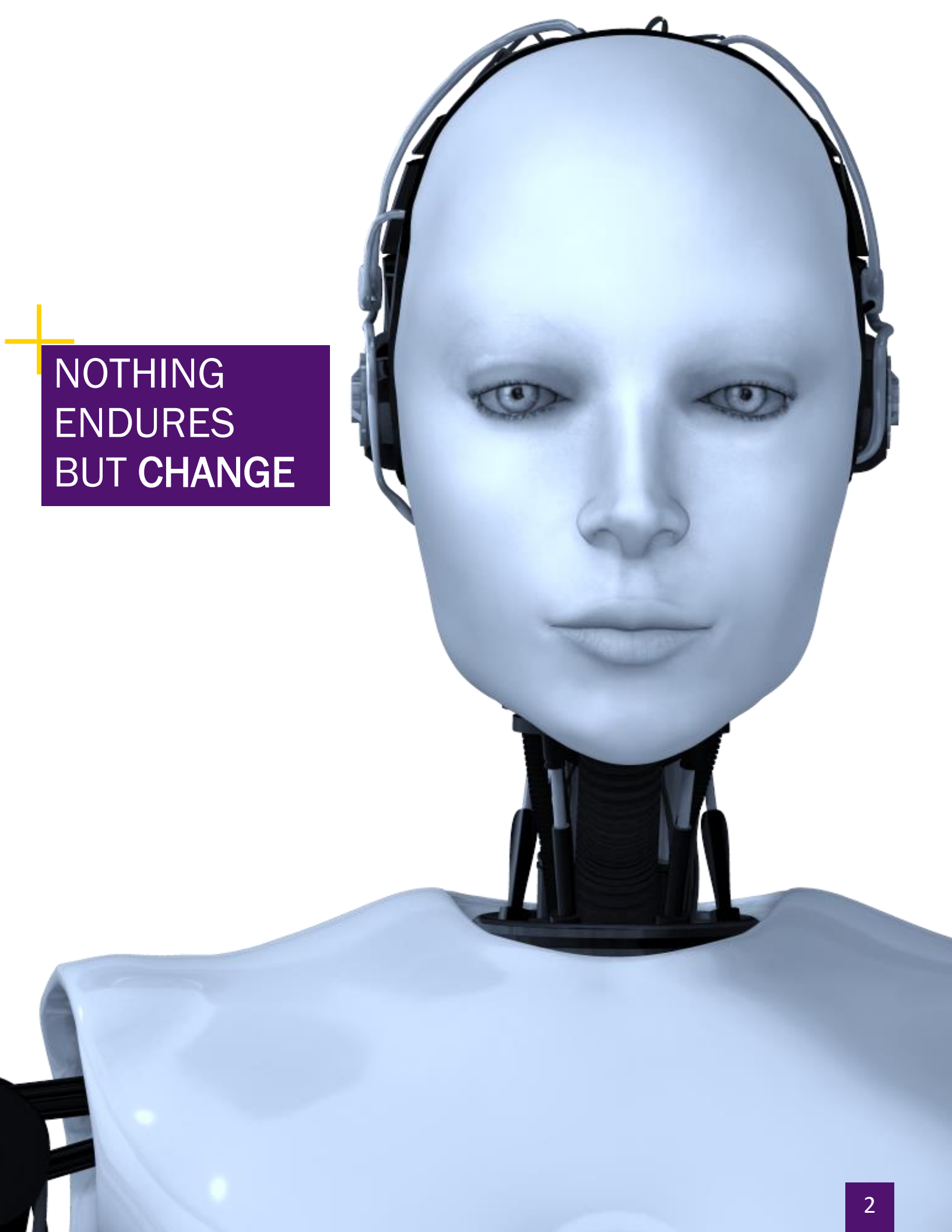
Despite this gloomy picture, Ontario is gaining strength in the development and adoption of disruptive automotive technologies. Connected cars, in-car software applications and big data analytics can address shifting consumer demands and power up Ontario's automotive sector once again.

Companies at the forefront of automotive disruption are increasingly coming from the tech sector, outside the traditional automotive ecosystem. This is evident in Google's self-driving car, Apple's iCar, Zipcar, and Uber. Partnerships with a host of players have the potential to re-draw the boundaries of the automotive ecosystem. This expanded network will encompass automakers, parts suppliers, software developers, high tech and environmental engineering firms and Internet-of-Things (IoT) entrepreneurs. Collaboration between heavy manufacturing and high tech, both of which have strong footings in Ontario, will bring a new wave of jobs and economic benefits.

At The Black Box Institute (TBBI), we are adept at helping clients embrace the change that is necessary to thrive in a shifting landscape. Our insights can help identify and track the disruptions that may affect your business model.

We are excited to share the sixth edition of this report with you and invite you to reach out to us with your comments and feedback.

NOTHING
ENDURES
BUT **CHANGE**



# MANUFACTURERS NEED TO PREPARE FOR CHANGING CONSUMER PREFERENCES, TIGTHENING REGULATIONS AND YET MORE DIGITAL DISRUPTION

# OUR APPROACH

Welcome to the sixth edition of our report!

In this edition, we have scrutinized the manufacturing and automotive ecosystems for emerging technologies and business trends. We have scanned hundreds of industry reports, articles, and news clips in search of the key technologies that will shape the future of the auto industry. We then applied a structured process to filter through technologies and trends with the potential to disrupt and transform the automotive industry by 2020. When the key technologies were identified, we placed these promising technologies in a framework to view them in a useful perspective.

We begin our report with advances in the broader manufacturing industry and move on to focus on the automotive sector. We highlight representative metrics of how each area of progress fulfills our criteria for driving economic growth, providing comparative advantage for countries, creating opportunities for the private sector, developing new products and services and driving new regulatory changes.

The technologies in this study are at different stages of maturity and are advancing at different rates. Some are expected to have disruptive impacts within 5 – 10 years. Our thinking will evolve as new trends and technologies are scrutinized. Advances with a high impact on our metrics today might erode over time, or be replaced by other new technologies, while others with a low impact may increase in importance.

# KEY TECHNOLOGIES

Manufacturing

## 3D Printing

Additive manufacturing/3D printing incorporates all techniques that create objects by printing layers of material based on digital models

## Big Data

Big Data analytics enable remote monitoring and predictive failure analysis that reduce costs and improve factory level utilization and productivity

## Robotics

Increasingly capable robots with advance d sensors, accuracy and intelligence are used to automate tasks

## Advanced Mining, Oil & Gas (MOG) Recovery

Techniques such as hydraulic fracturing make extraction of unconventional oil and gas economical

## Biomimicry

Imitation of the models, systems, and elements of nature for the purpose of solving complex manufacturing problems

## Flexible Manufacturing

The new age of manufacturing enables short-term control of manufacturing output and long-term optimization of production-unit configuration

## Virtual Manufacturing

Virtual manufacturing makes it possible to digitally design entire factories or individual pieces of equipment and run simulations against a range of production scenarios

## Autonomous Vehicles

Self-driving cars navigate and operate with reduced or no human intervention

## Drivetrain Electrification

Electric cars (full electric and hybrid) serve different usage patterns arising from changes in mobility behaviour, as well as new regulations

## Advanced Materials

Carbon fiber, aluminum, nano-steel, nano-structured carbon composites and bio-based materials are designed to have superior characteristics and functionality

## Hydrogen Fuel Cells

Fuel cells operate with a higher efficiency than diesel or gas engines and generate power with no pollution

## Alternative Fuels

Biodiesel, biomass, ethanol and CNG reduce dependency on oil and produce less pollution than gasoline or diesel

## Personal Mobility Vehicles

Two- or three-wheeled electrically powered one-passenger vehicles aim to make traveling freer and more fun

## Connected Vehicles

Machine-human interface increases situational awareness and reduce or eliminate crashes through vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) data transmission

# CURRENT LANDSCAPE

## Manufacturing

| Implications | 3D Printing | Big Data | Robotics |
|---|---|---|---|
| Drives economic growth & productivity | Aerospace companies are using 3D printing to apply new designs that reduce aircraft weight | | Industrial robots are becoming more autonomous, flexible, and cooperative |
| Provides comparative advantage for countries | | Accelerating the integration of IT, manufacturing and operational systems are making the vision of Industrie 4.0 a reality | Global demand for industrial robots to continue growth |
| Creates opportunities for the private sector | UPS Store Offers 3-D Printing to Stay Ahead of the Logistics Curve | Companies are turning to autonomous services for machine learning | How robotics will disrupt businesses |
| Originates new products and services | Small footprint metal 3D printers will drive growth | The industrial big data platform at work: The optimized wind farm | |
| Necessitates new regulatory changes | | | |

| Advanced MOG Recovery | Biomimicry | Flexible Manufacturing | Virtual to Real Manufacturing |
|---|---|---|---|
| The global oil glut is squeezing the US shale industry | Forces of nature: Biomimicry in robotics | The Industrial Internet of Things (IoT) decentralizes decision making, enabling flexibility in manufacturing | Manufacturers are increasingly making use of augmented reality |
| New LNG projects | | | |
| | How Audi merged biomimicry and urban mobility | Machine data and functionality will increasingly be deployed to the cloud | "Digital twin" cars improve aftersales service |
| | Autodesk and the pursuit of bio-inspired 3D printing | Divergent seeks to radically "dematerialize" auto manufacturing with micro factories | Virtual training on the factory floor |
| Obama urged to block future Arctic oil drilling | | | |

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# MANUFACTURING DEVELOPMENTS

## 3D Printing

With Industry 4.0, 3D printing will be widely used to produce small batches of customized products that offer construction advantages, such as complex, lightweight designs. High-performance, decentralized additive manufacturing systems will reduce transport distances and stock on hand. Aerospace companies are using 3D printing to apply new designs that reduce aircraft weight, lowering their expenses for raw materials such as titanium. [BCG]

The UPS Store was one of the first retailers to offer 3D printing service in-store back in September 2014 after testing the service in six locations across the US. Currently the company offers 3-D printing at over 100 stores using the Stratasys. To support this business-line the company announced that a start-up called CloudDDM would be introducing a full-scale manufacturing facility within UPS's worldwide air hub, located in Louisville. CloudDDM, whose customers include Whirlpool, GE Aviation, and GoPro offers industrial-grade parts and functional prototypes. [MH&L]

Industrial scale solutions will be in demand to serve applications in aerospace and medical industries for regular production of end use metal components. 2015 was characterized by huge sales revenue growth from large format metal systems sales. However, in 2016, SmarTech anticipates that the market will see the beginnings of a shift to growth in smaller footprint systems aimed not just at research applications, but for true small-scale manufacturing opportunities. [New Equipment Digest]

## Big Data

Industrie 4.0 is a German government initiative that promotes automation of the manufacturing industry with the goal of developing Smart Factories. Big data is already being used for optimizing production schedules based on supplier, customer, machine availability and cost constraints. Manufacturing value chains in highly regulated industries that rely on German suppliers and manufacturers are making rapid strides with Industrie 4.0 today. As this initiative serves as a catalyst to galvanize diverse multifunctional departments together, big data and advanced analytics will become critical to its success. [Forbes]

A 200-turbine wind farm provides an excellent way to understand the requirements of an industrial big data platform. Each turbine contains approximately 50 sensors and control loops with data sampled at different rates. The first level of analysis and interaction occurs at the edge – the wind turbine. Real-time analytics within the turbine controller, use sensor data collected, and saved in an onboard data historian, every 40 milliseconds to optimize the pitch of the turbine's blades, the conversion of rotational energy into electricity, and to determine whether electricity should be stored in / discharged from batteries or sent to the transmission grid. [GE Software]

As it gets increasingly difficult to find data scientists to mine the rapidly growing volumes of data for business insights, companies will turn to autonomous services for machine learning. These include offers such as Azure ML Studio from Microsoft, the Google Prediction API, Amazon Machine Learning, and IBM's Watson Analytics, which are helping to make machine learning more accessible. [Data Informed]

## Robotics

Kuka, a European manufacturer of robotic equipment, offers autonomous robots that interact with one another. These robots are interconnected so that they can work together and automatically adjust their actions to fit the next unfinished product in line. High-end sensors and control units enable close collaboration with humans. Similarly, industrial-robot supplier ABB is launching a two-armed robot called YuMi that is specifically designed to assemble products alongside humans. [BCG]

The global demand for industrial robots will continue to grow. Sales of industrial robots in China has been growing rapidly in response to the rising demand for automation. Demand in China is expected to reach 95,000 units in 2016. In 2016, major industrialised nations will adopt policies that will drive the market growth for industrial robots. Programs like Japan's "New Strategy for Robots", the US' "Advanced Manufacturing Partnerships" and China's "Made in China 2025" all contribute to the continued uptake of robots in the industrial and service sectors. [Electronics News]

The convergence of robotics with artificial intelligence, connected devices, cloud computing, biometrics and other technologies is creating the potential for large-scale, exponential disruption. For example, the industrial robot Baxter is able to learn tasks by mimicking humans and can be retrained across a variety of jobs. Baxter can be used for loading, sorting and handling materials at a cost of only US$4.32 an hour. Robots enable companies to lower labour costs, achieve better productivity and deliver consistent, superior quality. [Deloitte]

## Advanced Mining, Oil & Gas Recovery

As a worldwide oversupply has grown and the price of oil has dropped to a 12-year low, many shale oil producers have been forced to shut their doors or make cuts to keep costs down. According to law firm Haynes & Boone, 42 oil and gas companies filed for bankruptcy in North America in 2015. This number is expected to increase this year as the industry struggles to cope with mounting corporate debt and declining oil prices. A third of US oil and gas companies could be gone by the middle of 2017, according to Wolfe Research. [BBC]

The US liquefied natural gas (LNG) exports sourced from shale gas will debut in 2016 with the start-up of Cheniere's Sabine Pass terminal. New Australian LNG projects, such as Chevron's Gorgon, will add more capacity. Soft demand outside the US will further depress prices and some proposed LNG projects in the US, Canada and Australia will probably be delayed as a result. [The Economist]

US President Barack Obama could restrict the next office holder's room for manoeuvre on energy policy by setting a moratorium on oil exploration in the Arctic. The Bureau of Ocean Energy Management is expected to hand out drilling rights for offshore oil and natural gas leases and finalise it later 2016. The program will cover 2017 to 2022 and only sales outlined in the plan can later take place. [Climate Home]

*"Demand in China for industrial robots is expected to reach 95,000 units in 2016" [Electronic News]*

## Biomimicry

Systems based on nature are attractive to engineers for several reasons. They tend to work well with humans because their functional parts are soft, so they are not as hazardous as heavy industrial machinery with fast-moving metal components. Also, they tend to be simpler, because a lot of the time we replace complex electronic or mechanical control systems by simply making use of the properties of the materials of construction and how we actuate them. [The Engineer]

There are car concepts that nature provides: Does a car have to consist of rigid materials or can you use flexible membranes and pliable elements in the future that allow for novel functions, appearance and behavior? The cells regulating transpiration and gas exchange in plants (stomata), for example, have diverse shapes depending on water content. The sea raft (Velella), a marine creature, uses flexible structures in order to be driven by the wind. Can we employ similar strategies in order to equip our cars with new looks and functions? [Green Biz]

The PhD science students and masters in business and public health, working in teams are tasked by Autodesk specifically with using biomimicry as a lens for sustainable material innovation. The ultimate goal is to identify promising avenues for the development of high performance materials that are safe for people and the environment. An amazing example they found in nature is the beak of the Humboldt squid. The beak is hard enough for the squid to sever bones in its prey but it must have been formed from gelatinous material because the rest of the squid is. [Green Biz]

## Flexible Manufacturing

Today, only some of a manufacturer's sensors and machines are networked and make use of embedded computing. But with the Industrial Internet of Things (IIoT), more devices, sometimes including unfinished products, will be enriched with embedded computing and connected using standard technologies. This allows field devices to communicate and interact both with one another and with more centralized controllers, as necessary. It also decentralizes analytics and decision making, enabling real-time responses. [Automation World]

Companies are already using cloud-based software for some enterprise and analytics applications, but with Industrie 4.0, more production-related undertakings will require increased data sharing across sites and company boundaries. At the same time, the performance of cloud technologies will improve, achieving reaction times of just several milliseconds. As a result, machine data and functionality will increasingly be deployed to the cloud, enabling more data-driven services for production systems. Vendors of manufacturing-execution systems are among the companies that have started to offer cloud-based solutions. [BCG]

By using the 3D-printing technique for the aluminum nodes in addition to the use of carbon fiber tubes to join them, Divergent claims it is possible for car manufacturers to drastically reduce tooling and manufacturing costs, as well as cut development time and capital investment "by a factor of 20-50x relative to traditional methods". These micro factories may allow for a lot more diversity in auto manufacturing by lowering the financial bar to entry for start-ups and small-batch car makers. [Financial Times]

## Virtual to Real Manufacturing

Augmented-reality-based systems support a variety of services, such as selecting parts in a warehouse and sending repair instructions over mobile devices. These systems are currently in their infancy, but in the future, companies will make much broader use of augmented reality to provide workers with real-time information to improve decision making and work procedures. For example, workers may receive repair instructions on how to replace a particular part as they are looking at the actual system needing repair. This information may be displayed directly in workers' field of sight using augmented-reality glasses. [BCG]

During the lifetime of the car, its virtual model, created in the engineering phase and integrating all relevant data, will constantly be updated with performance data and data from exchanged parts. Using this virtual model, called the "digital twin". Producers can improve their aftersales service, offer a range of new services, and generate insights that can be used to optimize the design of future cars. [GE Reports]

Siemens has developed a virtual plant-operator training module for its Comos software that uses a realistic, data-based 3-D environment with augmented-reality glasses to train plant personnel to handle emergencies. In this virtual world, operators can learn to interact with machines by clicking on a cyber-representation. They also can change parameters and retrieve operational data and maintenance instructions. [Automation World]

# CURRENT LANDSCAPE

## Automotive

| Implications | Autonomous Vehicles | Drivetrain Electrification | Advanced Materials |
|---|---|---|---|
| Drives economic growth & productivity | Autonomous driving has a massive effect on annual mileage driven | A clear picture of the EV situation | The global carbon fiber market is projected to reach US$35.8B by 2020 |
| Provides comparative advantage for countries | | | |
| Creates opportunities for the private sector | 2016 will be the year of self-driving cars | | Auto industry shift to aluminum slower than expected |
| Originates new products and services | Tesla's autopilot technology voted the best | Battery technology development speeds up | A new way to select materials |
| Necessitates new regulatory changes | | Scrutiny from regulators will increase upon VW's emissions scandal | |

| Fuel Cells | Alternative Fuels | Personal Mobility Vehicles | Connected Vehicles |
|---|---|---|---|
| Can hydrogen fuel-cell vehicles compete with electric vehicles? | Biomethane is losing ground | Sci-Fi Flying Pods Could Replace Cars in the Very-Near Future | All new passenger cars sold in 2025 will be connected |
| | Oil price collapse threatens to weaken demand for palm oil in biofuel | | GM Canada announced $1M in donations to University of Waterloo |
| Honda and GM to open fuel cell plant by 2025 | | Google's autonomous “pod” cars hit the road | |
| Toyota is launching fuel cell car despite cheap gas | | Segway's latest take on personal mobility is a robotic helper you can ride | How many apps should over-loaded drivers be able to access? |
| | Biodiesel use will grow steadily over the next several years in the US, reaching 2B gallons by 2017 | | |

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# AUTOMOTIVE DEVELOPMENTS

## Autonomous Vehicles

When autonomous driving becomes available, it will have a massive effect on annual mileage driven: On long distances, 30% of end customers globally would substitute train travel for journeys in autonomous cars, and a further 13% would use autonomous cars instead of air travel. On short distances, a global 22% of end customers would substitute autonomous cars for taxis, and 31% would no longer use public transport, opting instead to use autonomous cars. [Automotive World]

Google and others will be able to start testing their autonomous vehicles in countries from Canada to Singapore in 2016, not to mention around 30 US cities. It is not just tech companies. Traditional carmakers are also joining the competition: GM, BMW, Volvo, Audi and Mercedes are among those planning to roll out self-driving features such as lane assist and adaptive cruise control in 2016. [The Economist]

Tesla's Model S has grown smarter. The latest software, version 7.0, introduced new semiautonomous driving features like hands-free lane-keeping, automatic lane changing, and automated parallel parking. Tesla's Autopilot is not flawless, but compared with the systems from Mercedes and BMW, it does a better job of staying centered in its lane, tracking around bends, and allowing the car to cruise for longer periods without driver input. [Car&Driver]

## Drivetrain Electrification

In the new 2015 Global Automotive Mobility Study, 6,500 end consumers from ten automotive core markets have drawn a clear picture of the EV situation: the main obstacles are the still-high prices (64% of respondents), limited operating range (53%) and insufficient availability of charging stations (41%). And many end customers say they "miss the fun of the ride" – without ever having tested one. [Arthur D. Little]

For years, advances in battery technology lagged expectations. Battery capacity and cost are preventing EVs from becoming mainstream. Many players are working on the cost side, such as Tesla designing a battery mega factory. Bosch is working on highly advanced battery concepts, and progress on lithium-ion batteries has been recently propelled. Battery performance may improve much faster during the coming years, but progress and timing are not clear. [Automotive World]

Scrutiny from regulators will increase upon VW emission scandal, with those in the US, Europe and elsewhere speeding up their plans to introduce real-world emissions testing to supplement that performed in laboratories. Although this is unlikely to happen before 2017, it comes on top of a planned rollout of emissions limits and fuel economy standards. In the US, Corporate Average Fuel Economy (CAFE) standards will become fully mandatory in 2016. [The Economist]

## Advanced Materials

The global carbon fiber reinforced plastic (CFRP) market is projected to reach $50B by 2020. The global carbon fiber market is projected to reach $5B by 2020, at a CAGR of 9.1% between 2015 and 2020. This growth is fuelled by the increasing production capacities of Boeing and Airbus, rising demand for fuel efficient vehicles, and growing application of CFRP in other industries such as sporting goods, civil engineering, and wind energy. [MarketsandMarkets]

Novelis, the world's largest rolled aluminum producer, warned that plans to shift rolling mill capacity to automotive body sheet are progressing slower than anticipated as automakers prove slow to follow Ford's lead in widespread use of the metal. Novelis CEO said the industry is going through a 'digestion period' after Ford adopted an aluminum body in its top-selling F-150 pickup model. Other automobile manufacturers have not followed with similar major commitments for leading models. [Reuters]

Elsevier aims to provide web-based, digital solutions to select advanced materials. Elsevier allow engineers and equipment manufacturers to look across material types to select the optimum material for their application, regardless of what the key performance outcomes need to be. Which means properties regarding cost, manufacturability, even performance thermodynamics, are all normalized and combined with proprietary equations to analytically determine the best material, along with the necessary information solutions. Being able to compare materials, side by side, is helpful, when you need to replace something that's very heavy or expensive. [Industry Week]

## Fuel Cells

Does the hydrogen fuel-cell vehicle (HFCV) have a chance against the Electric Vehicle (EV)? No. And here is why: 1) Hydrogen is not an energy source. It is a form of storage. Energy needs to generated, that can help to extract hydrogen from a source material like natural gas or water. 2) EVs are at least three times more energy efficient than hydrogen fuel cell vehicles. 3) A multi-billion-dollar hydrogen delivery infrastructure needs to be built. 4) Hydrogen is not clean. About 95% of hydrogen in the US is made from natural gas in large central plants. [Automotive News]

Back in 2013, Honda and GM signed a long-term agreement to develop hydrogen fuel cell technologies together. The agreement stated that they would co-develop technologies that each company would use for its own cars. The first fruits of this project have been used in the Honda FCX Clarity, which debuted at the 2015 Tokyo Motor Show, is expected to go on sale in 2016. According to reports, Honda and GM are expected to build a new plant and begin mass-production of fuel cells by the year 2025. [Overdrive]

Toyota will be launching its Mirai fuel cell car in 2016 in California despite falling gas prices, a weak network of hydrogen fueling stations and media obsession with Tesla. There are only a handful of hydrogen stations up and running in California, but the California Fuel Cell Partnership has plans for 40 stations to operate by the end of 2016 and 100 by 2020. The state of California is spending about $20M a year on the project. [USA Today]

*"The car of the future will be electric, connected and self-driving." [McKinsey]*

## Alternative Fuels

Biomethane (also called 'renewable natural gas' or 'biogas') is methane produced naturally and is a high-grade energy source. It can be used as a replacement for natural gas. As waste diversion programs take effect and better ways to use the waste stream are implemented, biomethane production from landfills is expected to decline. [The Guardian]

Crude oil's slump has been so severe that it's now threatening the government-aided biodiesel programs in the world's top producers of palm oil. Indonesia may miss its target of raising blending to 20% if crude stays below $30 a barrel. The slump in crude will impact the implementation of the biodiesel program in Malaysia. The two nations account for 86% of the global palm oil supply. [Bloomberg]

The US Environmental Protection Agency (EPA) released the final volume requirements for bioethanol under the Renewable Fuel Standard (RFS) for the years 2014, 2015, and 2016. The EPA has increased the required levels from its earlier suggestion, and hopes that the rule will boost renewable fuel production and provide for growth of the biofuels industry. The final 2016 standard for advanced biofuel is nearly 1B gallons, or 35%, higher than the actual 2014 volumes, while the total renewable standard requires growth from 2014 to 2016 of over 1.8B gallons of biofuel, or 11% higher than 2014 actual volumes. Biodiesel standards will grow steadily over the next several years, reaching 2B gallons by 2017. [Biofuels International]

## Personal Mobility Vehicles

Traffic is the worst, and even subway commuters are not immune to wasting precious minutes in gridlock. A NASA Space Act company called skyTran hopes to offer a futuristic solution to personal travel. The so-called skyTran, a monorail that would hover 20 feet above regular roads, would transport passengers in pods at speeds of up to 150 miles per hour. After decades of development, the revolutionary idea is finally hitting the real world. [Tech Insider]

After months of fine tuning at Google's private testing facility in central California, a few of the bubble-shaped vehicles have started to circulate around the company's headquarters to further adapt to real world driving scenarios. The cars represent concrete evidence of Google's vision for self-driving cars, which amount to fully automated vehicles that can carry two people and a modest amount of groceries or other items. [USA Today]

Though it has been adapted to a number of inventive shapes and sizes ranging from three-wheeled patrollers to self-balancing two seaters, the Segway never quite found the commercial success envisaged when the first models appeared in 2002. Now the company is bringing robotics into the mix to give it a new edge. The Segway Robot builds on the company's approach to self-balancing urban transport by converting into a robotic helper once you hop off. The Segway Robot was developed in collaboration with Intel and Chinese robotics firm Ninebot. [Gizmag]

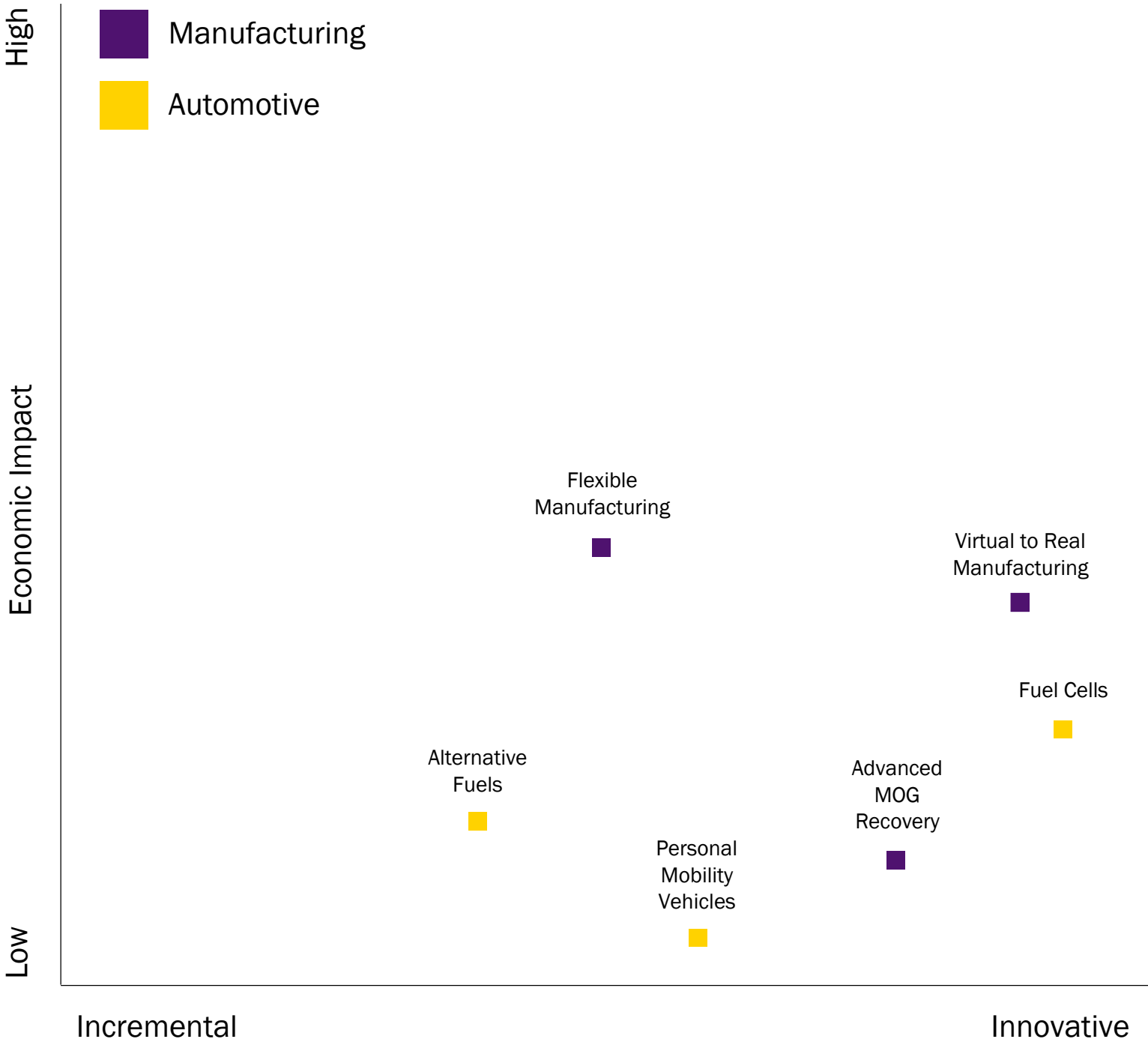
## Connected Vehicles

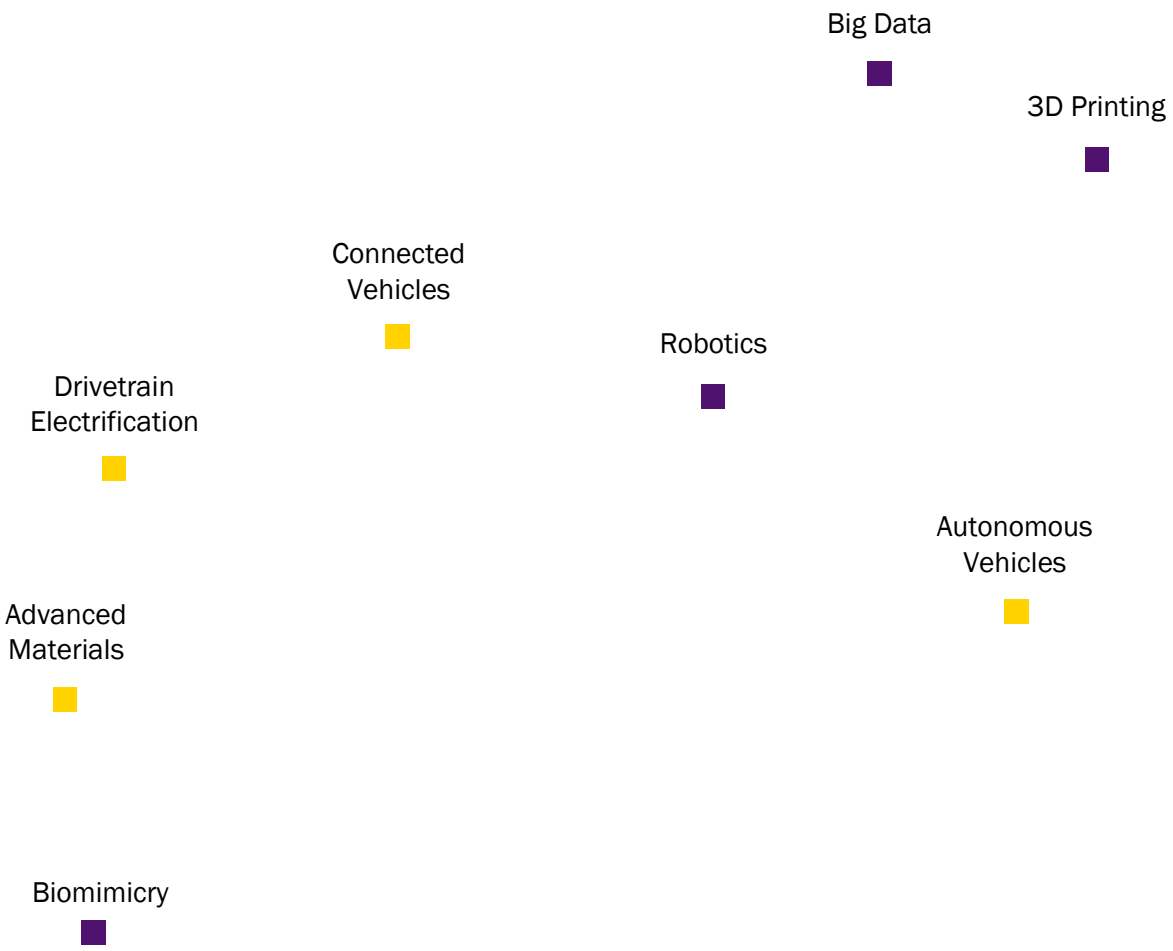
Vehicle connectivity is expanding at a rapid rate. In fact, all new passenger cars sold in 2025 will be connected. To meet consumers' heightened expectations, OEMs will have to make sure that consumers' smartphones, tablets, and other devices work seamlessly within their vehicles. But relying on in-house development resources alone will be insufficient to meet expectations. The future will be defined by the convergence of a powerful connected vehicle ecosystem where a wide range of business partners — automakers, telecommunications companies, start-ups and aftermarket service providers — will coexist and cooperate to deliver solutions. [Accenture]

In November 2015, GM Canada President announced $1M in donations to University of Waterloo for two engineering partnerships: one related to connected car software development; and two to greener vehicles. GM also announced that it will establish an innovation zone within Waterloo-based Communitech, with an initial focus on exploring urban mobility and connected car solutions. [Onboard]

Innovative apps are everywhere, but car makers are worried about issues of security and reliability, making it unlikely that they will open the doors to every kind of app you can think of. They will want to maintain some control over developers, while also limiting the number of apps available in the car. [Forbes]

# CURRENT STATUS OF THE DIGITAL REVOLUTION






Impact

Disruptive

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