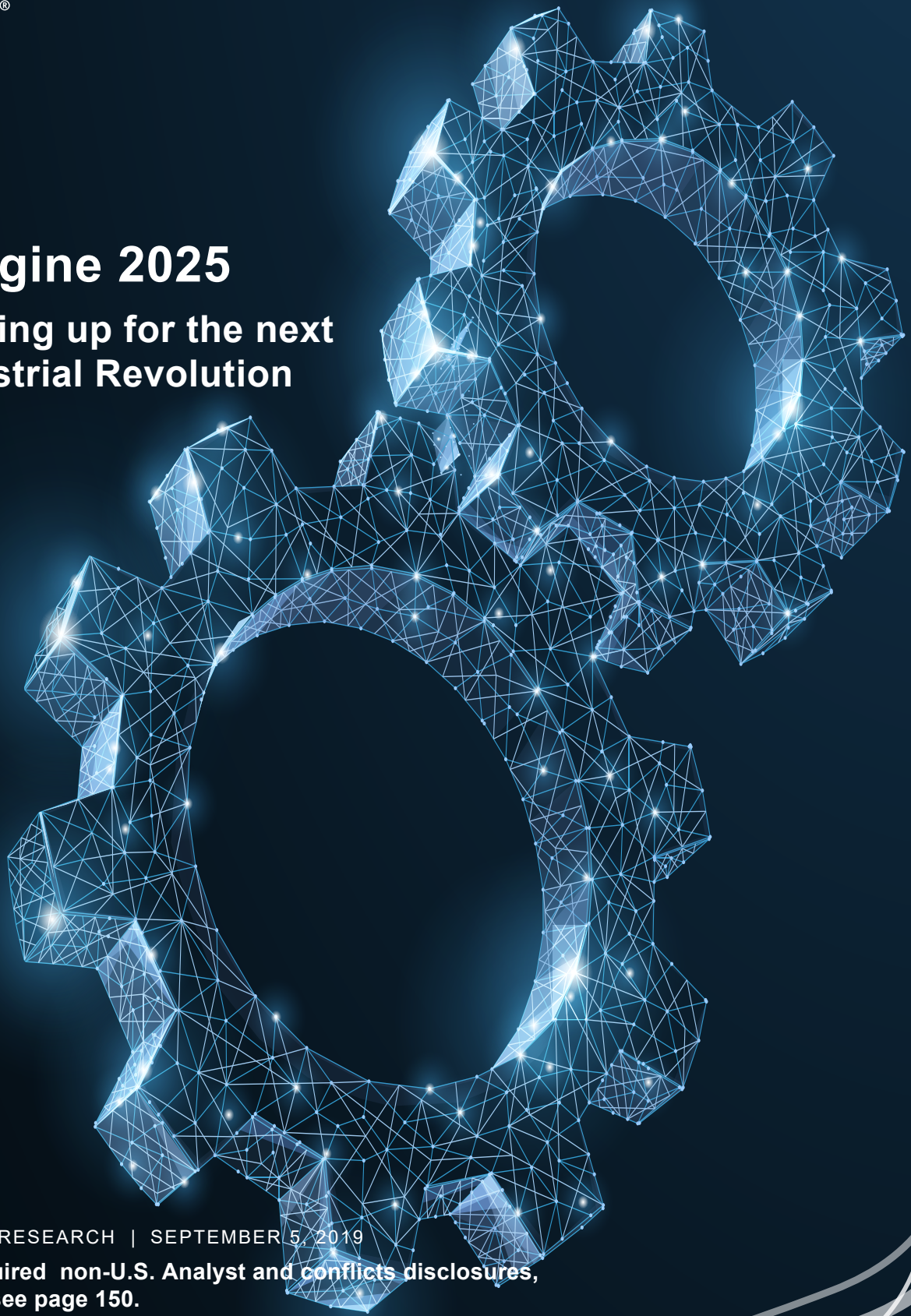
Capital Markets

Imagine 2025

Gearing up for the next Industrial Revolution



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A message from the Directors of Global Research

We at RBC Capital Markets are constantly challenging ourselves to be differentiated and provide unique perspectives. We aim to add value to our clients and distinguish ourselves as thought leaders in our respective industries in which we conduct and provide research. We like to stimulate debates conducted by those with diverse perspectives, not for the sake of being provocative, but to initiate a more comprehensive discussion about our researched sectors and companies. This often involves forecasting projections and returns for the future, and then assigning a valuation based on those estimates. This type of analysis usually assumes no major structural changes of the external environmental forces that serve to shape the economic and business landscapes. We collectively decided to challenge ourselves to be more creative about what that future might look like. In 2017, RBC Capital Markets embarked on an ambitious six-month study of the global drivers of parabolic change. We began by identifying a fairly large number of "change forces" that we believe will catalyze a metamorphosis of the world around us. The six themes that emerged from this work – The Calibrated & Augmented Self, The AI Race, Collective Action, Escalating Uncertainties, The Agility Imperative and In Cloud We Trust – formed the outline of **Imagine 2025.**

Following up on our **Landmark Imagine 2025 Study** and **Additional Imagine 2025 Research**, our Global Industrials Research team collaborated to provide a roadmap for investors and industry leaders alike to navigate the change forces determining the global industrial landscape for the future.

Ultimately, we believe a new industrial revolution may be upon us, driven by six themes consistent with our Imagine Framework—where advancements in artificial intelligence, customization capabilities and cloud technology set against an uncertain geopolitical and environmental backdrop force industrial players to collaborate with competitors and increase their agility to survive. And while post industrial revolution advancements such as the combustion engine, assembly line and global trade have underpinned the industrial world over the past century, we believe artificial intelligence, autonomous transportation and cloud technology, among other significant innovations, could completely transform the industrial marketplace within the next 5-10 years and for the foreseeable future.

Our call to action is this: with the pace of change accelerating, Industrials stakeholders must place increased focus beyond the next few quarters and into the years ahead. This way of thinking has already been well adopted by GM CEO Mary Bara and CN CEO Jean-Jacques Ruest, who joined our Imagine 2025 discussion.

Our hope is that this report provokes a range of thinking that allows readers to proactively consider how emerging technologies, innovations and global trends will impact the industrial world and the fates of both companies and customers intertwined within it. We encourage readers to look laterally and think critically as they make their way through the report, reflecting upon how developments in one industry may influence others and developing a framework to anticipate which companies are blazing trails of change. We also hope to equip our readers with a thematic roadmap to develop new questions they should be considering and posing to management teams and industry leaders.

As always, please reach out to us with your feedback, thoughts and questions.




Graeme Pearson
Head of Global Research

Justin Spitzer
Head of US Research

Rufus Grantham
Head of European & APAC Research

Andre-Phillipe Hardy
Head of Canadian Research

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Executive summary

The Imagine 2025 Industrials Edition: Following on from our landmark RBC Capital Markets report Imagine 2025: Themes, Opportunities and "The Law of Accelerating Returns" study, we look to apply our learnings to the global industrials sector. As a reminder, through our Imagine 2025 process we identified 23 change forces that manifested into six themes we believe will ultimately define the global industrials sector's future through 2025. These themes are The Artificial Intelligence Race, The Calibrated and Augmented Self, In Cloud We Trust, Collective Action, Escalating Uncertainties and The Agility Imperative.

Theme I: The Artificial Intelligence (AI) Race: We believe we are on the precipice of the Artificial Intelligence (AI) era. Software, enabled by machine learning (training algorithms on input data) and deep learning (using neural networks) can replicate and eventually surpass human cognition. It is helpful to think about AI technology in phases as a progression: Narrow AI, General AI and superintelligence or "the singularity." Each stage of AI development has different implications for different industries and the world at large. Leading industrials implications include: 1) autonomous vehicles becoming mainstream, and the emergence of Transportation as a Service (TaaS); 3) smart, autonomous farming and mining, 4) preventative maintenance and "lights out manufacturing" and 5) increasing adoption of AI in talent sourcing.

Theme II: The Calibrated and Augmented Self: "The Calibrated and Augmented Self" is the concept that everything in the future is personalized; a stark contrast to the mass production, consumer products, media and healthcare of yesterday. Over the past two decades, the proliferation of choice has trained customers to expect more goods and services that mirror their specific needs and preferences. Our dialogue with company C-suites indicates a majority of companies understand the power of mass customization, however, the means to do so in a profitable way has not existed—until now. Big data, artificial intelligence, and advancements in technology are now enabling products, services, and experiences to cater specifically to an individual customer with lower levels of friction (at a very basic level). As we move forward, we believe the convergence of 3-D printing, advanced automotive electronics and coatings, the bioengineering of crops, virtual reality and drones will all drive much more personalized and affordable offerings.

Theme III: In Cloud We Trust: The adoption and utilization of cloud technology is rapidly changing the landscape of corporate IT as well as corporate competition across industries. The democratization and affordability of cloud computing and storage is fueling the rate at which companies can start, scale, and succeed. As basic cloud services become more affordable with price cuts, we think premium services such as intelligence, machine learning, and advanced compute will continue to be introduced at affordable rates, giving high-power tools and capabilities to businesses of all sizes. Access to, and utilization of, these tools increases the ability of small and new entrants to industries to keep giants on their toes. Against this backdrop, software and digital capabilities are supplanting physical assets in importance among industrial players and sensors anywhere from a car to a farm are collecting unprecedented amounts of data.

Theme IV: Collective Action: The power to act collectively has never been greater given technology and the viral speed with which social sharing can occur. As a result, long-held beliefs in traditional institutions, social norms, and commerce are being challenged. Trust in one's peers vs. legacy institutions is quickly taking hold, as is the idea of decentralized organizations vs. centralized ones. As a result, we believe the pace of disruptive change will accelerate, but also believe increased collaboration between historical adversaries could increase, as incumbents seek to partner for survival via self-cannibalization and disruptors seek change at scale. In either case by 2025, we believe, as history has taught us, collective action will have transformed industries, evolved business models, and challenged the status quo. We add that Environmental, Social and Governance (ESG) is a key component of the Collective Action theme.

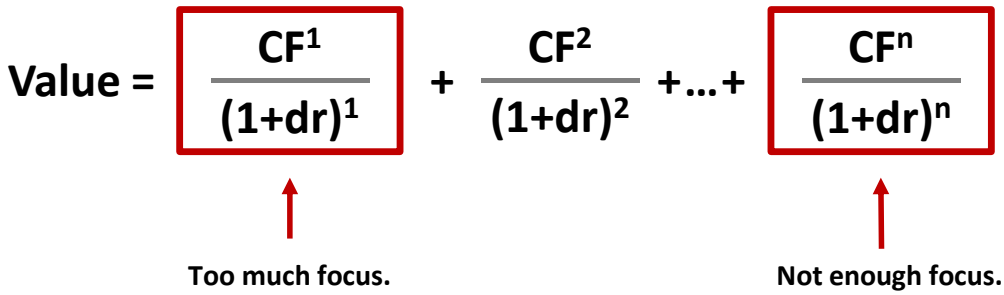
Theme V: Escalating Uncertainties: Even as we struggle with a staggering amount of change, we can envision a future where this rate of change goes parabolic, making our present concerns seem quaint, heightening uncertainty, and expanding the list of threats and challenges posed to the world's nations, institutions, and corporations. The sheer scale of change has significant economic, environmental and resource considerations. We have already seen the shoots of violent extremism and economic and political nationalism as nations react differently to shifting societal realities. As we look forward, we see the potential for two paths – an adherence to the post-war tenets of globalization, inclusion and joint solutions, or a hard turn towards nationalism and isolation in all its forms. These uncertainties create the opportunity for innovative solutions to global conflicts and resource allocation, but equally increase the potential for a fragmentation of global institutions, military and economic threats, and a chasm between the haves and have-nots. Among these global shifts, government regulation, urbanization and resource scarcity, including the global water crisis, stand out as the most pertinent among industrials.

Theme VI: The Agility Imperative: The Agility Imperative is based on the increasing need for companies to be flexible and able to quickly adapt to the societal change forces. An asset base and existing brand equity will no longer be enough to carry companies through changing times, or to sustain dominance and relevance in a category. In fact, it may lead to their extinction. Companies will have to change their structures and culture to adapt. To that end, we encourage companies to follow our four agility mandates 1) make people believe, 2) consider a new business model, 3) partner where possible and 4) lighten up – practices we expect to play out through the evolution of staffing, the expansion of services to extract more returns from physical install basis, offsite home manufacturing and partnerships between industrial and tech leaders.

Why we engaged in this study

Equity valuations are based on the present value of future cash flows. Most analysis is focused on the next quarter or next 1-2 years, but rarely is time and effort taken to think about the next 6 years when assessing the valuation of a company. This was the impetus for the RBC research team. We wanted to equip our analysts and clients with a multidimensional way of thinking about companies, stocks and valuations. The most important assessment for our research team was to understand which companies across our collective coverage had the capabilities to adjust to a rapidly evolving future.

Exhibit 1: Focus on Value Creation



Source: RBC Capital Markets

Understanding "the law of accelerating returns"

All of our six future themes by 2025 are rooted in dramatic and accelerating advancements in technology. Before we discuss each of these themes in more detail, we thought it would be helpful to explain why we have conviction these (at times uncomfortable) themes are in the not too distant future. Ultimately, exponential technology advancement always has been and will continue to be underpinned by five underlying principles: 1) new technology; 2) the network effect; 3) ability to store information; 4) faster pace of mass adoption; and 5) rising affordability.

Exhibit 2: Exponential technological change is rooted in the combination of 5 principles

Source: Augmented

Greek philosopher Heraclitus' quote "the only thing that is constant is change" may be true in the proverbial sense, though it is not a fair representation of the state of play today. Change is not constant; it is accelerating at a dramatic pace. We believe this accelerating pace of change has been driven partly by faster rates of adoption around new technologies. It took about 46 years before electricity received mass adoption. However, the time for mass adoption of the telephone and radio was only 35 years and 31 years, respectively; the personal computer took about 16 years, and the iPhone took less than 3 years.

Exhibit 3: The accelerating pace of change

Year Developed	Technology	Years until mass adoption
1872	Electricity	46
1876	Telephone	35
1897	Radio	31
1926	Television	26
1975	PC	16
1983	Mobile Phone	13
1991	The Web	7
2001	iPod	4
2006	Facebook	3
2007	iPhone	2.5

Source: Augmented

The Imagine 2025 Portfolio

As identified in the **Imagine 2025 portfolio**, we believe the companies best positioning and reinvesting to win in 2025 and beyond include: Albemarle, Aptiv, Canadian National Railway, Cargojet, Deere, General Motors, Hexagon AB, Ryanair, Roper, SNC-Lavalin Group, Tesla, WSP Global and Xylem.

Analyst	Sector	Company	Ticker	Imagine 2025 Portfolio Justification
Brewer	Transportation	**Ryanair Holdings**	**RYA**	Ryanair's cost advantage to peers with no debt and market leading margins, gives it scope to take share in a growing market. It carries 130m people pa (almost half the EU population) and is CF positive after growth capex and delivers an above 20 ROE. Ryanair is making the necessary investments in digital to protect its own distribution from intermediaries, and even disrupt other travel and leisure retail industries.
Dray	Electrical Equipment & Multi-Industry	**Roper**	**ROP**	Roper is unique to the Multi-Industry space given its focus on asset-light, high free cash flow businesses with recurring revenues, and more than half of its earnings from SaaS. The robust free cash flow and negative working capital provide Roper with plenty of optionality for future investments.
		Xylem	**XYL**	With one of the highest technology offerings in the water sector, Xylem is favorably positioned to the global mega-trend of water quality, scarcity, and safety. In our view, Xylem has the early lead/first-mover advantage in the new market for smart water systems.
Rizvi	Industrial Goods	**Hexagon**	**HEXAB**	HEXAB has long been among the leaders in preparing for the digitization of construction and manufacturing industries in our view. The group's offerings are built around combining sensors and software to improve productivity and are well aligned to the 'Internet of Things'. The recent introduction of its Smart Convergence Platform which brings edge intelligence across its hardware and a growing position in offerings to develop autonomous driving are examples of this.
Spak	Autos	**General Motors**	**GM**	GM is an automotive leader in the robo-taxi opportunity. This opportunity allows them to shift from selling units to miles. Selling miles could be a larger TAM with higher profit, and reduced cyclicality. These factors could lead to a re-rating.
		Aptiv	**APTV**	The company has positioned the portfolio to be a key supplier for signal and power architecture need in vehicles of the future, autonomous driving and connectivity. Aptiv is also adopting new business models and is one of the first companies to show real-world monetization of their autonomous vehicle investment.
Spracklin	Transportation and Industrials	**Cargojet**	**CJT CN**	Tangible growth opportunities: CJT is seeing demand growth in virtually all of its areas, including B2B and ecommerce driven B2C. Strong market position: CJT is uniquely positioned in the time-sensitive overnight cargo segment, with ~95% market share and ~75% contracted volumes. Set-up for operating leverage: With reduced headcount and optimized fleet, daytime revenue would come on with incremental expenses and wider margins.
		Canadian National Railway	**CNR CN**	Our constructive outlook on CNR sector is based on the following strengths: (1) unparalleled three coast network with access to key volume gateways (Prince Rupert, Gulf Coast); (2) long-term pricing growth; (3) best-in-class service and operations (4) commitment to implementing technology (automation, data analytics).
Spronck	Industrials Products	**WSP Global**	**WSP CN**	Engineering firm with a focus on designing for the future. Expertise in skyscraper design, rail transit, aviation and modern infrastructure, is well positioned to capture end-market demand from global population growth and urbanization trends. Additionally, we expect WSP to continue to participate in the consolidation trends we see developing over the next decade.
		SNC-Lavalin Group	**SNC CN**	SNC-Lavalin has design-to-build capabilities in clean power, rail transit, nuclear, and renewable energy – segments we see strong long-term growth trends. Additionally, SNC-Lavalin is able to participate in the ownership of assets as more governments globally employ private-public partnerships (PPP) to help finance large infrastructure projects.
Viswanathan	Chemicals	**Albemarle**	**ALB**	Electric vehicle play. #1 global producer of lithium which will be used heavily in electric vehicle batteries for at least the next decade.
Weber	Machinery	**Deere**	**DE**	We expect the trend toward "smart farming" -- including AI/machine learning -- to accelerate as farmers search for ways to maximize productivity/yield, improve crop quality, and reduce costs/improve machine uptime in the face of relatively low commodity prices and stressed natural resources (land/water). We see Deere as well positioned for this trend.

Theme I: The Artificial Intelligence (AI) Race

We are on the precipice of the Artificial intelligence (AI) era. Software, enabled by machine learning (training algorithms on input data) and deep learning (using neural networks) that can replicate and eventually surpass human cognition. It's helpful to think about AI technology in phases as a progression: narrow AI, general AI and superintelligence or "the singularity." Each stage of AI development has different implications for different industries and the world at large.

What you need to know

With the emergence of big data and more pervasive computing power, AI has started entering real-life applications. To date, AI is still solving fairly basic tasks. But the ingredients are there for AI to accomplish something much more substantial. We believe the application of AI will have very broad implications across industrial sub-sectors over the next 5-10 years. Among the different Technology Change Forces we have identified, we believe that AI may well be the most impactful.

There are three types of AI:

1) **Narrow AI:** The most immediate application of AI. Automates a single activity that outperforms human efficiency.
2) **General AI:** Performs any intellectual task a human can and is sometimes referred to as human-level AI.
3) **Super AI:** Super-Intelligence, aka the Singularity, is achieved when AI becomes much smarter than humans.

Key Artificial Intelligence Race developments include:

Autonomous vehicles, robo-taxis and Transportation as a Service (TaaS) could have many direct societal benefits including greater safety, a lower cost of transportation, and providing mobility to those that may not otherwise have had access. But there are tangential benefits as well, for instance, cities and real estate could be reimagined, with municipalities as well as insurance and media companies all potentially poised to profit.

Predictive maintenance and "lights out" manufacturing could completely revolutionize current manufacturing processes.

Smart farming will help feed the world as on-farm tech adoption and data-driven decisions support more efficient planting/production and help address challenges including rising food requirements and limited resources.

AI will help you find your next job as traditional staffers and newer entrants are increasingly adopting AI to more effectively source qualified talent, increase candidate engagement, and streamline typically time-consuming recruiting/interviewing/hiring functions

Companies highlighted: GE, Siemens, Honeywell, Emerson, ABB, Schneider, AMZN, Grainger, GM, Ford, Tesla, Aptiv, Veoneer, Volvo, PPG, Axalta, Albemarle, Google (Waymo), Alphabet, CN Rail, British Airways, Air Canada, EasyJet, PepsiCo, Deere, AGCO, NVIDIA, Waste Management, Zillow, Redfin, MHK, SHW

The Industrial AI Revolution

The next frontier in the evolution of industrial manufacturing has arrived. Coined colloquially as "Industry 4.0", this so-called Fourth Industrial Revolution fuses the physical and the digital worlds through the application of machine learning, smart factories, advanced automation, and intelligent supply chains—all powered by rapidly-advancing Artificial Intelligence capabilities. To be clear, this is the next phase of the journey *after* the Industrial Internet of Things and data analytics. While most industrial companies are still scrambling to install software capabilities and sensors into their legacy analog equipment, first-movers including GE and Siemens are already moving on to the next big challenge of feeding the data collected by their connected devices into new AI-powered solutions. We are still many years away from "Industry 4.0" becoming mainstream, but the early seeds of progress are already sprouting in select applications within the global sector. In our view, here are four primary ways in which this Fourth Industrial Revolution will transform and optimize manufacturing processes and create radically new business models:

1. Smarter Robots and Adaptive Manufacturing

When hearing the words "Artificial Intelligence", the first image that pops up into most people's minds is hyper-intelligent robots. But while robotics and automation are already widely employed across manufacturing supply chains today, the truth is that the majority of these current-generation robots are not particularly "smart". That is to say, most industrial robots in use today are designed for only a narrow range of actions, such as routine labor like heavy lifting, drilling, assembly, welding, etc. While these robots are certainly more dexterous and precise in their movements than humans are, their roles are often limited to only a discrete function within the assembly line.

With the advent of Artificial Intelligence and more advanced engineering, the Holy Grail is to eventually design robots that are truly flexible and adaptive in their skillsets, with the ability to perform a multitude of tasks and the "brains" to recognize different scenarios and react accordingly. Longer-term, we think the ability of these next-generation robots to think critically will eventually match that of their human counterparts, allowing manufacturers to automate a broader spectrum of their assembly lines and drive improved cost efficiencies and yields.

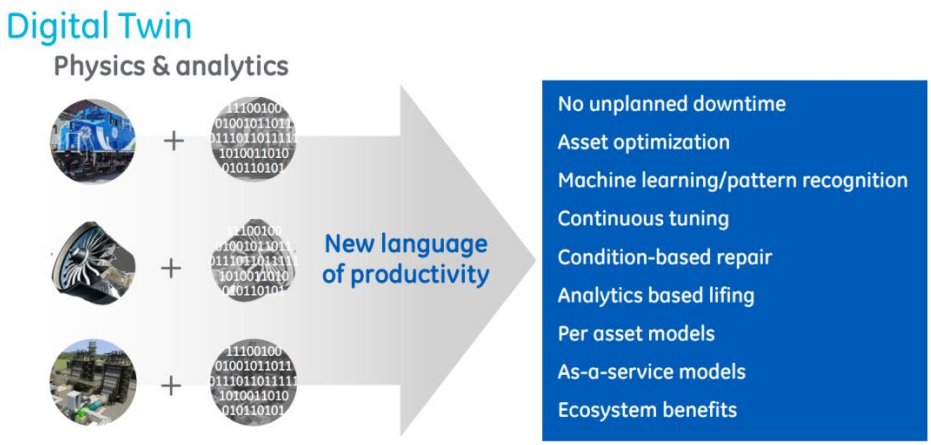
2. Predictive Maintenance

Of the different ways in which Artificial Intelligence can be employed within the industrials, predictive maintenance is arguably the one that is the most established and widely-used today. Traditionally, industrial equipment and systems are serviced based on a fixed, pre-determined schedule, irrespective of their utilization rates or underlying condition. However, the result is often a mismatch between maintenance needs and the actual servicing of the equipment, creating inefficiencies, wasted labor costs, and potentially undiagnosed equipment deficiencies. However, with the introduction of sensors, smart instrumentation, and data analytics, manufacturers are now able to monitor their equipment more accurately and customize maintenance schedules using Artificial Intelligence according to each device's individual usage and strain. By leveraging AI-enabled predictive maintenance, Hewlett Packard estimates that manufacturers will be able to achieve a 60% or more reduction in unscheduled system downtime. Similarly, McKinsey found that AI-enhanced predictive maintenance of industrial equipment can produce a 10% reduction in annual maintenance costs, up to a 20% downtime reduction, and 25% reduction in inspection costs.

The industrials sector is also increasingly relying on "Digital Twins", which are virtual replicas of physical assets that can assist companies in performing predictive maintenance. Using an array of sensors, data analytics, and physical and AI models, manufacturers can build physics-based virtual models of their large-scale machinery — whether it be aircraft engines, gas

turbines, or locomotives. This process of "Twinning" a piece of equipment allows human operators and maintenance personnel to better track the performance data and utilization of the machines to perform servicing on a need basis rather than an arbitrary fixed schedule. This would also allow technology companies like Siemens and GE Digital to pitch new business models to customers, such as outcome-based performance contracts that ensure certain metrics like uptime, yield, and cost savings.

Exhibit 4: GE Digital Twin

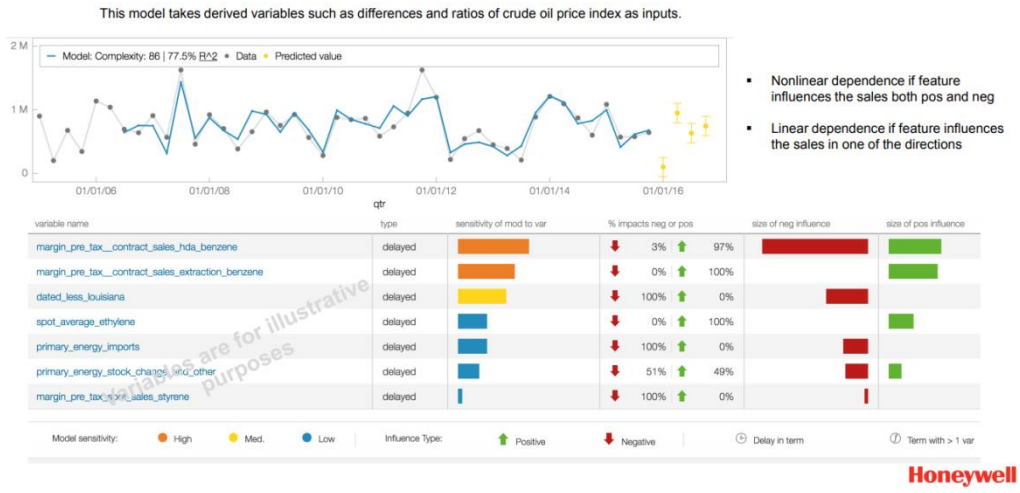


Source: Company reports

3. Demand-Driven Production

At a broader level, the implementation of Artificial Intelligence can eventually automate entire production supply chains based on forecasted macro considerations. By leveraging real-time data on trends like order patterns, customer spending, macroeconomic activity, geopolitical developments, and even weather patterns, these "dynamic" supply chains will ideally be able to proactively flex/adjust their output, procurement, energy consumption, inventory and financing decisions, pricing, and more to accommodate the state of the market on an ad hoc basis. In our view, this type of "intelligent" production mechanism would be mutually beneficial to both consumers and manufacturers, as it would theoretically allow supply and demand to more closely align with one another in a cost-efficient manner. Within the Multi-Industry sector, Honeywell is already integrating AI and machine learning algorithms across its procurement, strategic sourcing, and cost management initiatives. Longer term, McKinsey estimates that machine learning will reduce supply chain forecasting errors by 50% and improve product availability to the market.

Exhibit 5: Honeywell AI-Based Product Demand Forecasting Model



Source: Company reports

4. Automated Quality Control

Another key application of AI and machine learning is for quality assurance within product assembly lines. In the past, most manufacturers would use manual and routine inspections to identify and remove low-quality products before they came off the assembly line. However, major improvements in sensors, cameras, and machine learning algorithms would empower manufacturers to discover defects with increased efficiency/accuracy and improve quality control across the entire manufacturing process. The ability to detect variances across hundreds of units in seconds rather than hours could drastically reduce costs and production downtime, increase yields (percent of units that pass quality control), enhance productivity, and improve customer satisfaction with their products.

Putting It All Together

With these principles and applications of Artificial Intelligence in mind, the utopian "factory of the future" can be envisioned. Today, these hyper-intelligent and adaptive manufacturing facilities are being conceptualized and prototyped by GE through its "Brilliant Factory" initiative. These factories will house an ecosystem of smart robots, advanced sensors, and computers that can communicate with one another in real-time to ensure that the production line runs smoothly and that product quality remains pristine. Today, many of GE's factories already operate using lean manufacturing best-practices, additive/3D-printing capabilities, and advanced software analytics powered by Predix. In the future, the company aims to inject Artificial Intelligence to further upgrade these facilities to react in real-time to order trends and operate multi-modal manufacturing services, whereby existing machines can adjust their output across a range of different products, depending on demand.

Automation Should be a Key Future Trend

Industrial automation drives higher productivity, quality, uniformity, flexibility, and safety. Industrial automation is the use of controls systems (ex. computers or robots) and information technologies for handling various processes and machineries in an industry to replace a human being. There have been leaps and bounds in the evolution of industrial automation, and bigger picture, the practice has evolved from initially increasing productivity (ex. machines can work 24x7) and reducing human costs (ex. wages and benefits) to increasing quality, flexibility, and safety.

Industrial automation can be grouped into three buckets: discrete, hybrid, and process. It is important to note the distinction between discrete and process automation. Discrete automation helps assemble engineered components or sub-assemblies into more valuable final products. Discrete automation is used where production steps happen one after another, and control is about speed and positioning. Think of discrete automation as the controlling of so-called widgets on an assembly line. Automotive is perhaps the best example of an industry that emphasizes discrete automation. On the other hand, process automation applies to controlling the production of liquid and gases, as in what flows through a pipe. Process Automation utilizes manufacturing operations that convert highly variable raw materials into consistent quality final products. This tends to require a higher degree of automation, monitoring, and advanced simulation and control. This type of automation is also referred to as "continuous" and is used in processes, such as refining, where there is continuous feedstock and the output is homogenous. Process automation will monitor aspects such as temperature, flow, and pressure. The best example of process automation would be producing a barrel of oil. Lastly, hybrid automation has elements of both discrete and process automation and tends to focus on applications where production occurs in batches. This type of automation has focuses on recipe and ingredient management and controlling the temperature and pressure of processes. An example is a brew house.

High upfront costs are the main drawback. All of these aspects mentioned above remain vital to most industrial industries, and seemingly the only deterrent to utilizing industrial automation is the high initial investment cost associated with transitioning from a manually controlled/monitored production line to a fully automated process (including training humans to handle the new, potentially sophisticated, equipment). Below we walk through some key customer needs that are ongoing business drivers for automation.

According to McKinsey, the manufacturing sector generates more data than any other at roughly two exabytes (one billion gigabytes) annually.

Exhibit 6: Key Automation Business Drivers

Source: Rockwell Automation company reports

- **Faster Time to Market:** Automation companies work with customers in the design and implementation phase of their respective automation investments, allowing them to ultimately increase flexibility and agility to respond to customer needs more quickly.
- **Lower Total Cost of Ownership:** Helping customers reduce the total lifecycle cost of their automation investment, including upfront investment, ongoing operating costs, and long-term support of the installed base.
- **Improved Asset Utilization:** Against a backdrop of increasing global competition, customers need to constantly find ways to optimize assets and improve utilization. Automation products and services help customers maximize throughput and minimize costly downtime.
- **Enterprise Risk Management:** Industrial processes touch many aspects of enterprise risk, and automation companies help customers design, operate, and maintain a safe and secure operating environment. This includes intellectual property related to machine and production processes, and regulatory and environmental compliance.

Long-Term Secular Tailwinds

Megatrends of urbanization, energy savings, and a growing middle class are all accelerating the demand for automation. Automation companies are positively predisposed to benefit from several long-term secular trends currently underway, and similar trends have been outlined by several Multi-Industry peers. We recognize the merit in the trends longer-term, but believe they will be somewhat gradual in materializing and not necessarily something that can drive sales meaningfully higher in the near-term. Below are some of the key trends as outlined by a May 2015 study by McKinsey.

- **Urbanization:** The global urban population is growing by approximately 65 million annually with an expected 150% increase in emerging market annual consumption from 2010 to 2030. This should mostly be a function of the growing middle class and is expected to be a tailwind for consumer goods and energy consumption.
- **Accelerating Technological Change:** One trillion objects are expected to be connected to the internet by 2025. There has been an explosion of network connections and the bandwidth required to support these industrial assets, with security and reliability being a key concern and need from customers.
- **Aging Workforce and Skills Gap:** The share of older workers in the workforce is expected to increase from 14% in 2010 to 22% in 2030. This rapid change is all about replacing humans with more efficient machines and that are less prone to errors. In addition, it helps combat the growing skill gaps seen in many industries. It is estimated in the US alone, there are as many as 800,000 unfilled jobs because people do not have the necessary STEM skillsets.
- **Greater Global Trade:** There has been a 5x increase in global trade and financial flows from 1990 to 2012. This concerns the growing interconnectedness of plants and global supply networks with customers looking to optimize every part of the product lifecycle.

P&G Relationship with Rockwell Automation Shows Emphasis on Automation

Procter & Gamble customer perspective from Rockwell Automation's 2015 analyst meeting sheds light on benefits of automation offerings. Procter & Gamble presented an interesting case study of the benefits it reaped from Rockwell Automation's offerings at Rockwell Automation's annual analyst meeting in 2015 in Chicago. The benefits that Procter & Gamble realized included $50 million in productivity savings, a 20% increase in throughput, a 30% reduction in scrap, and a 50% extension of lifecycle.

- Rockwell Automation accounts for 70%-80% of Procter & Gamble's automation spend, and it touches essentially all segments at Procter & Gamble.
- **The systems are typically in place for 15-20 years.**
- **Automation accounts for 15%-20% of Procter & Gamble's total capex of roughly $4 billion annually at the time**, implying roughly $700 million in annual automation spending with roughly $525 million specifically through Rockwell Automation.
- Automation spending at Procter & Gamble is increasing roughly 5pp annually as a percent of capex with a path to 30%.
- **Procter & Gamble believes Rockwell Automation's offerings in general are superior to Siemens and Emerson**, and notes that Rockwell Automation's typically "premium" prices are warranted given the stronger products and services vs. more commoditized offerings from some peers.

Stock Implications

Key automation players should see a nice runway for secular growth. Among our coverage, we consider Emerson is best positioned, while Honeywell and GE also have automation exposures (though they are arguably trapped in the large conglomerate structures). Other key players include Rockwell Automation, Siemens, ABB, Schneider, and Fanuc.

Growth of Robotics and "Lights-Out" Manufacturing

Truly "lights-out" manufacturing likely still many years away, though represents the pinnacle of automation and should be a disruptive force. "Lights-out" manufacturing is a term used for manufacturing processes where factories run on a fully autonomous basis with no need for any human intervention on site (and therefore can be run with all the lights turned off). Some of the key draws to a truly "lights-out" factory are the lower energy costs including lighting and potentially HVAC, increased productivity given the ability to theoretically run factories 24/7, and smaller factory footprints with likely lower rents. The factories are optimal for running very repetitive tasks with large production volumes over a long period of time. In contrast, some of the concerns and drawbacks include elevated initial capex costs, the potential inability of the factory to cope with unforeseen issues that could cause meaningful costly downtime, and the societal impacts of eliminating certain human jobs. That said, it has been widely documented how new jobs supervising robots and other aspects of the factories should be created. In the end, robots and automation are increasingly being incorporated into company production facilities, though fully "lights-out" facilities are rare.

- **Key robotics manufacturers should benefit from the increasing automation of manufacturing facilities.** These include Fanuc, Kuka, Rockwell Automation, ABB, and Yaskawa Electric.

Exhibit 7: Fanuc Robots

Fanuc has one of the most well-known "lights-out" manufacturing facilities, which has been open since 2001 where its robots make other robots.

Source: Roboprogram

Warehouse Automation Specifics

The growing trend of warehouse automation aims to improve throughput, limit downtime and cope with rising labor costs. In May-2019, we hosted a dinner with the former COO of a leading global warehouse automation company in Chicago, IL. Many of the familiar themes were present, such as limiting downtime and addressing rising labor costs. In terms of what's the next big thing in the space, our expert expects more of an evolution than any breakthrough revolutions and believes that the technology is there, it just needs to be more broadly adopted. This could include the expanded use of shuttles and simpler "goods to person" applications. Below we walk through the key takeaways.

- **Investable takeaways for our coverage: Honeywell's Intelligrated likely set for ongoing solid growth, though no obvious warehouse automation deals are likely on the horizon.** Among our coverage, Honeywell's Intelligrated business is the main read-across from our dinner. The key takeaways we had are that it will likely be challenging for Intelligrated to make meaningful inroads into Europe and Asia given already solidly entrenched local players, though the Transnorm deal does help with Europe. Next, we do not see any

obvious meaningful acquisition targets for Intelligrated, though there could be ongoing tuck-in deals that help plug products gaps or geographic voids. More broadly, robotics looks to be a focus area for M&A in the warehouse automation vertical in the next several years.

- **Global material handling market has a total addressable market of +$29 billion according to Honeywell.** The market is roughly 25% in North America growing roughly 7%, roughly 30% in Europe growing roughly 7%, roughly 15% in China growing roughly 9%, and the remaining roughly 30% is scattered throughout the globe. Based on our estimates, Honeywell's Intelligrated business has roughly 5% market share and generates roughly $1.5 billion in annual sales including the new Transnorm business, which expands its presence into Europe vs. Intelligrated's stronger North America footprint. According to Modern Distribution Management, the other top global materials handling system suppliers include Daifuku/Wynright, Schaefer, Dematic (part of KION), Vanderlande Industries, and Murata Machinery. In North America, the leading players are Dematic, Intelligrated, and then Daifuku/Wynright. In Europe, Schaefer, Swisslog, and Dematic tend to be the leaders.
- **Amazon is the 800-pound gorilla in warehouse automation and has a meaningful first-mover advantage.** Amazon is the largest source of demand for warehouse automation and we heard sound bites where a few years ago Amazon was basically able to consume all of the manufacturing capacity at the top several warehouse automation manufacturers, though the manufacturers had to be restrained and keep their customer base somewhat diversified. At this point Amazon's demand seems to be moderating somewhat, but it is still clearly large. The company's purchase of Kiva Robotics in 2012 for $775 million (roughly 6.5x sales) was a watershed moment in material handling and warehouse automation, and the multiple was extremely high for what is arguably viewed as robotics. Kiva makes automated guided vehicles (AGVs). After acquiring the company, Amazon essentially shut out other customers of the firm from being serviced and constricted their ability to function. In the end, it appears that Amazon does not truly have an unsurmountable technical advantage vs. peers, as others have found similar AGVs, though its scale is simply so much larger that it has a strong first mover advantage. It was noted that for warehouse automation Amazon Business is not treated any differently than Amazon, though it may have specific areas in fulfillment centers. Finally, note that Amazon outsources its services and maintenance of the warehouse automation systems as that is not its core competency.

Amazon is the largest source of demand for warehouse automation and we heard sound bites where a few years ago Amazon was basically able to consume all of the manufacturing capacity at the top several warehouse automation manufacturers.

Exhibit 8: Amazon Warehouse

Source: Recode

- **Warehouse automation customers tend to be sticky because switching costs are so high.** Customers that have found warehouse automation suppliers they like tend to stick with them given the service components and familiarity. Also, if a firm were to suddenly switch to a new supplier, there could be mismatches in software and other complications. As a result, incumbent suppliers tend to have an advantage and customers will only switch if there are truly major issues. For example, Grainger has used Dematic for many of its DCs (especially higher-end parts) and other players have found it hard to displace them. Note that Grainger uses Daifuku/Wynright for some more commoditized structural steel shelves and other less automation-intensive products.

Warehouse automation continues to outgrow GDP. The growth should tend to track ecommerce growth, which is widely viewed as growing 10%-15% Y/Y (according to the industry expert we hosted in May) in the near- to medium-term. That said, the waning spend by Amazon is one headwind to monitor. Further, the group is not immune to recessions as sales broadly declined by roughly 40% in 2008/2009. In terms of profitability, the warehouse automation players tend to generate EBIT margins in the mid-teens with ROIs on their projects mostly in the 20%s from the customer's point of view. Next, in terms of the initial split of hardware vs. software in a system, it tends to be roughly 85% hardware and roughly 15% software to start.

Autonomous is coming and ready to disrupt transportation

Artificial Intelligence (AI) is a key enabler for four major disruptive trends within automotive: connectivity, shared mobility, electrification, and autonomous driving. For instance, AI in connectivity can create a better user experience and new potential revenue streams by predicting driver habits such as anticipating that the passenger wants to stop for coffee on the way to work and routing them to a local Starbucks, or by improving maintenance scheduling. In shared mobility, AI enables more accurate, predictive routes, which improve arrival times, utilization and pooling. In electrification, AI can help with battery thermal management, manufacturing operations, and cost reduction. However, the most disruptive automotive use case of AI is likely for autonomous driving.

Autonomous driving improves safety and provides mobility for those that may otherwise not have had access to it. However, the true power of autonomous to transform the mobility landscape and economic opportunity is the convergence of AVs with another mega, macro trend – a culture of shared. As has been documented in many aspects of society from music to housing, young adults and urban populations have begun to shun ownership, especially when it relates to an asset with a high capital cost. The combination of sharing and autonomous vehicles gives rise to robo-taxis and the emergence of a new modality of transportation.

To be clear, there are already vehicles on the road with "automated features," though these vehicles operate with L0 to L2 (with some aspects of L3) "assisting" driving capabilities. This is otherwise known as ADAS (advanced driving assistance systems). These systems offer features such as automatic emergency breaking (AEB), adaptive cruise control (ACC), or lane-keep assist (LKA), which are increasing prevalent on vehicles in part due to increasing regulation and in part due to consumer demand. As AI evolves, the path to full autonomy should continue to advance (Level 4/5 vehicles).

Exhibit 9: SAE levels of autonomy

Source: SAE International J3016

For autonomy, we think the benefit to society is multi-fold. First is safety. In the U.S., there are ~37k road fatalities per year and >2.7 million injuries. Global fatalities are closer to 1.2 million. Experts believe that nearly 95% of those accidents are caused by human error. So if AI can provide a safer autonomous driving experience versus human driving, lives are saved. Secondly, time – arguably the most valuable asset – is freed up. Productivity can increase as travel times and city congestion can be brought down. From a supply chain perspective, this presents the opportunity for disruption (and potentially higher content per vehicle for suppliers) as the inside of a vehicle likely will be transformed. A third benefit, and perhaps the most future-dated, includes the potential re-shaping of the city landscape. Estimates show that roughly one third of all urban and suburban landscapes is for the vehicle. With robo-taxis, square footage set aside for parking spots and garages can now be freed up.

From a business perspective, the model can shift from one of vehicle ownership to one of pay-per-mile giving way to the concept of Transportation as a Service ("TaaS"). We believe the economic profit opportunity for those that capitalize on TaaS can be great. The ramifications are far reaching, impacting municipalities (who can rethink urban planning and potentially lessen the need for public transportation), but also insurance and legal. Further, automakers and suppliers alike have recently been talking about the potential for new "meta" data created to be monetized. Similar to how the smartphone created a whole new eco-system of business, so too can the autonomous vehicle.

As we think about the progression of autonomy enabled by AI, Levels 1-3 are essentially advanced safety and convenience features. Levels 1-2 are in vehicles today and should experience rapid growth as active safety becomes democratized. There are some examples of vehicles with some Level 3 capabilities on the road today, but these are limited. However, we expect automakers to begin to offer Level 3 capabilities in luxury vehicles and high-end option packages as they can make solid margins off these products. Level 4/5 vehicles are generally viewed as the "autonomous vehicles." Here, we believe the first use cases will be in a shared autonomous or "robo-taxi" business model. This is because of two main factors: cost and technological progress.

Today's AVs are expensive. This is driven by the sensor suite (including expensive LiDAR sensors), the computing power, the complicated electrical architecture system, the software, required R&D, and the low levels of volume to start. For instance, we believe that GM's Cruise Bolt AV probably costs near ~$200,000 to produce (MSRP for the retail Bolt is $36,620). Now these costs will likely come down over time as sensor costs decrease and scale picks up. However, putting an expensive AV in a ride-sharing construct, the utilization can be much higher than the ~12,000 miles/year that an owned vehicle may incur. For example, as shown below, we estimate that the average cost per mile to operate a vehicle (using US averages) is ~$0.87 mile. If that vehicle were to cost ~$200,000, which an autonomous vehicle might today, that would cost $3.23/mile – a clear luxury. However, putting that autonomous vehicle in a shared fleet where the vehicle could put on ~70,000 miles a year (current networks like NYC taxis, Uber and Lyft support this) lowers the cost to the consumer to $1.55/mile. And that is fully depreciating the vehicle over 3 years, assumes 5x the annual maintenance costs and gives the operator of that vehicle a 15% return. At a more scaled cost (of sensors and technology) under the same assumptions, the cost would be ~$0.58/mile. If the vehicle "pools" riders, that cost per consumer could be cut in half. Note for this analysis, we assumed the powertrain is still gasoline as we view the autonomous and electrification trends as independent, even though they are converging.

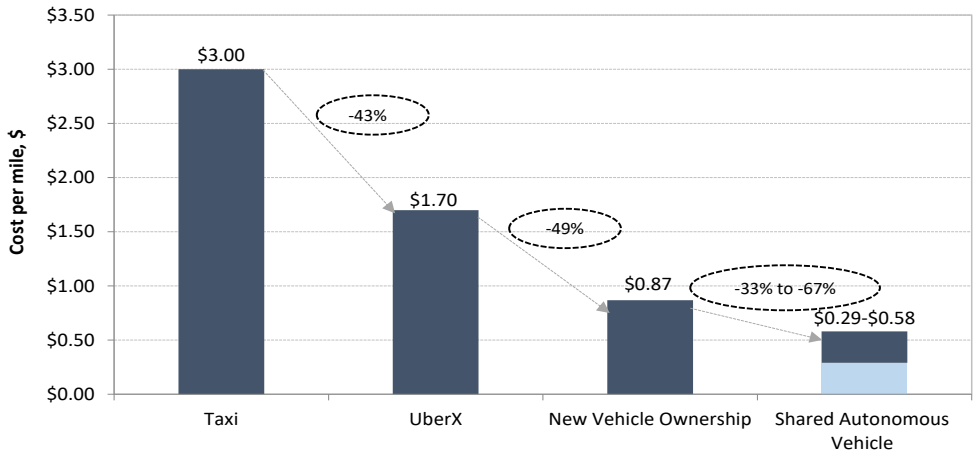
Exhibit 10: US cost per mile economics of new vehicle ownership, owned autonomous, and share autonomous vehicles

New Vehicle Ownership		Owned Autonomous Vehicle		Shared Autonomous Vehicle		Shared Autonomous Vehicle - scaled cost	
Vehicle Transaction Price	$35,000	Vehicle Transaction Price	$200,000	Vehicle Transaction Price	$200,000	Vehicle Transaction Price	$50,000
Years vehicle owned	5	Years vehicle owned	5	Years vehicle owned	3	Years vehicle owned	3
5 year residual value	35%	Residual value	35%	Residual value	0%	Residual value	0%
Residual Value	$12,250	Residual Value	$70,000	Residual Value	0	Residual Value	0
Depreciation	$22,750	Depreciation	$130,000	Depreciation	$200,000	Depreciation	$50,000
Annual depreciation	**$4,550**	**Annual depreciation**	**$26,000**	**Annual depreciation**	**$66,667**	**Annual depreciation**	**$16,667**
Vehicle Transaction Price	$33,000	Vehicle Cost	$200,000	Vehicle Cost	$200,000	Vehicle Cost	$50,000
Down payment, %	15%	Down payment, %	15%	Down payment, %	15%	Down payment, %	15%
Down payment, $	$4,950	Down payment, $	$30,000	Down payment, $	$30,000	Down payment, $	$7,500
Loan amount	$28,050	Loan amount	$170,000	Loan amount	$170,000	Loan amount	$42,500
Loan term (months)	69	Loan term (months)	69	Loan term (months)	36	Loan term (months)	36
Annual interest rate, %	5.00%	Annual interest rate, %	5.00%	Annual interest rate, %	5.50%	Annual interest rate, %	5.50%
Annual interest	**$1,435**	**Annual interest**	**$8,698**	**Annual interest**	**$9,589**	**Annual interest**	**$2,397**
Average vehicle miles travelled per year	12,000	Assumed average vehicle miles travelled per year	12,000	Assumed average vehicle miles travelled per year	70,000	Assumed average vehicle miles travelled per year	70,000
Average New Car MPG	25	Average assumed MPG	25	Average assumed MPG	25	Average assumed MPG	25
Gasoline, $ per Gallon	$3.00	Gasoline, $ per Gallon	**$3.00**	Gasoline, $ per Gallon	**$3.00**	Gasoline, $ per Gallon	**$3.00**
Total financing costs	$1,435	Total financing costs	$8,698	Total financing costs	$9,589	Total financing costs	$2,397
Assumed annual depreciation costs	$4,550	Assumed annual depreciation costs	$26,000	Assumed annual depreciation costs	$66,667	Assumed annual depreciation costs	$16,667
Assumed annual insurance costs	$1,150	Assumed annual insurance costs (70% of current)	$805	Assumed annual insurance costs (70% of owned)	$805	Assumed annual insurance costs (70% of owned)	$805
Assumed annual maintenance costs, tires	$1,186	Assumed annual maintenance costs, tires	$1,186	Assumed annual maintenance costs, tires (5x owned cost)	$5,930	Assumed annual maintenance costs, tires (5x owned cost)	$5,930
Assumed license, taxes, registration, misc	$665	Assumed license, taxes, registration, misc	$665	Assumed license, taxes, registration, misc	$665	Assumed license, taxes, registration, misc	$665
Depreciation per mile	**$0.38**	**Depreciation per mile**	**$2.17**	**Depreciation per mile**	**$0.95**	**Depreciation per mile**	**$0.24**
Interest per mile	**$0.12**	**Interest per mile**	**$0.72**	**Interest per mile**	**$0.14**	**Interest per mile**	**$0.03**
Insurance, maintenance, other per mile	**$0.25**	**Insurance, maintenance, other per mile**	**$0.22**	**Insurance, maintenance, other per mile**	**$0.11**	**Insurance, maintenance, other per mile**	**$0.11**
Fuel cost per mile	**$0.12**	**Fuel cost per mile**	**$0.12**	**Fuel cost per mile**	**$0.12**	**Fuel cost per mile**	**$0.12**
				Cost to operate an autonomous vehicle	**$1.31**	**Cost to operate an autonomous vehicle**	**$0.50**
				Marginal Operator Return	15%	**Marginal Operator Return**	15%
Total Cost per mile: new vehicle ownership	**$0.87**	**Total Cost per mile: shared autonomous vehicle**	**$3.23**	**Total Cost per mile: shared autonomous vehicle**	**$1.55**	**Total Cost per mile: shared autonomous vehicle**	**$0.58**

Source: RBC Capital Markets estimates

If we then compare the cost per mile economics of owning a vehicle and the potential of a shared autonomous vehicle to current taxi and UberX rates, we see the potential for these vehicles to meaningfully disrupt both ride-sharing 1.0 and vehicle ownership.

Exhibit 11: Cost per mile economics for various mobility solutions



Note: Taxi and UberX analysis assumes an average trip distance of 10 miles traveled. New vehicle ownership analysis assumes 12,000 miles traveled annually. Shared autonomous analysis assumes 70,000 miles traveled annually. Assumed gasoline @ $3.00/gallon and average MPG of 25.
Source: Uber, Taxi Fare Finder, ALG, and RBC Capital Markets estimates

On technology, while Autonomous AI technology has made great progress, it is still limited. As such, we see a phased rollout of the technology.

a) **Phase 1: Geo-fenced Robo-taxis.** Since many of the technologies still rely on high definition (HD) mapping and governments may want to test/trial the public's willingness and readiness of the technology, it makes sense that autonomous will start in small zones within city limits. Initially, this could prove to be disappointing to some customers as it limits the usability of the product (i.e., they may not be able to take the service to the airport). This likely will not impact vehicle ownership as it is not a true substitution for ownership, but likely starts supplanting ride-sharing 1.0 businesses (think current Uber/Lyft) as it would likely be more cost competitive taking out the largest cost which is

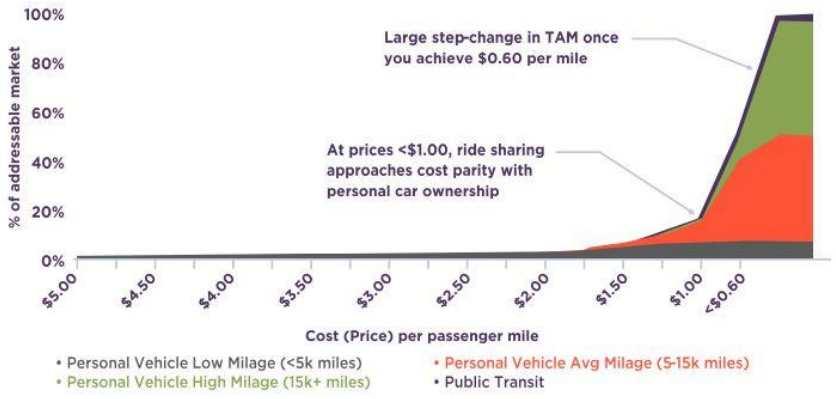
the driver. This is the beginning of the shift to change a marginal cost (the driver) into a fixed cost (the AV) and yield greater scale.

b) **Phase 2: Robo-taxis beyond a geo-fenced area.** The natural evolution of the above. This likely still requires HD maps, but also increasingly relies on the AI of the vehicle (and we assume that the AI technology improves over time). It is this phase that could begin to impact vehicle ownership – if coverage is sufficient. Still, there may always be a segment of the population that wants the flexibility (and intangible benefit) of having their own vehicle. For those people, we will eventually have…

c) **Phase 3: Autonomous vehicles in your garage.** The technology and costs scale, and autonomous becomes a feature you can own. This would start on luxury vehicles or high-end option packages (think ~$10-$15k option) allowing automakers to generate good margins (replacing some ADAS revenue streams as that product becomes democratized) before the tech here too becomes democratized.

While the robo-taxi TAM opportunity will likely still be nascent in 2025, we believe that it will grow exponentially through 2050, requiring technology companies, OEMs and suppliers alike to invest today to be able to capitalize on the trend. As price per mile declines, with advancement of autonomous technology as a key enabler, a large chunk of the TAM should be unlocked. In estimating the potential TAM, the global average miles driven per year is ~7,500 (in the U.S. it is closer to 12,000 miles/year). On average, we assume that "owned" vehicles will drive ~7,000/year, a lower amount (and decreasing over time) presuming that even those who own vehicles will at times use autonomous vehicles on demand. For autonomous vehicles on demand, globally, we assumed they will put on 75,000 miles/year or a 10x improvement in the annual utilization of the asset. This results in ~40% of total miles driven in 2050 driven by autonomous vehicles on demand or ~7.7 trillion miles. If the operators of these robo-taxis were able to collect $0.50/mile, that is a ~$3.8 trillion TAM in 2050 (in today's dollars). Note there were ~94 million vehicles sold globally in 2018, which if we assume an average transaction price of $22,500 yields a $2.1 trillion market for selling vehicles.

Exhibit 12: Potential unlocking of TAM as price/mile decreases



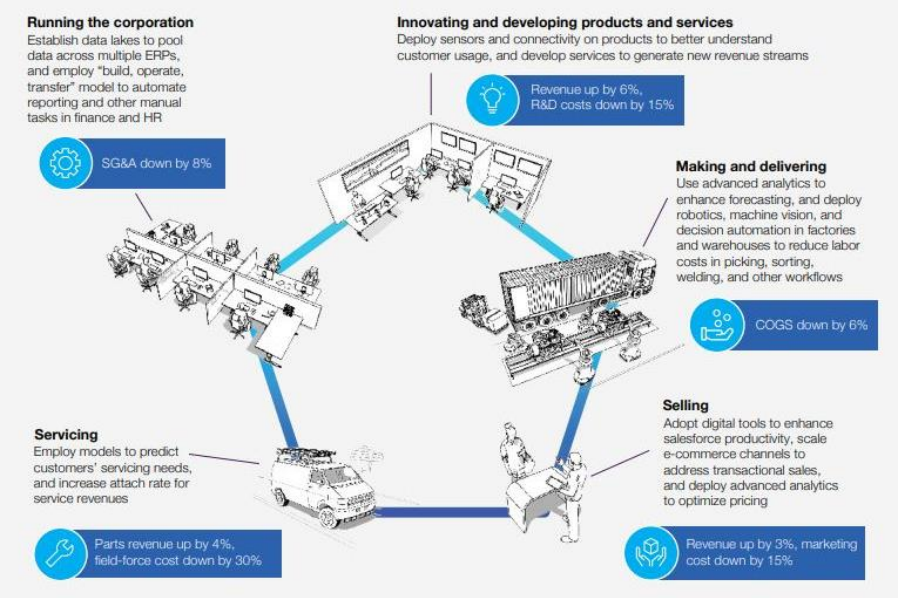
Source: General Motors

AI in automotive beyond autonomous driving

While autonomous driving seems to get much of the AI attention, we believe the "Industry 4.0" benefits can be meaningful. As the industrial sector and automotive manufacturing transition to factories enabled by wireless connectivity, sensors and the internet of things, we see an opportunity for greater supply chain management and working capital benefits. According to McKinsey & Company, a successful enablement of technology could unlock ~$0.8-$2.0 trillion in total return to shareholders (+9-22%), driven by revenue growth and

efficiency gains. Within the automotive sector specifically (entire value chain), McKinsey estimates ~$207-$367 billion in revenue growth as well as another $116-$259 billion in efficiencies.

Exhibit 13: What successful tech enablement could look like for an OEM



Source: McKinsey & Company

Imagine 2025: The Cruise Opportunity

General Motors and AI

In 2016, GM began preparing for the future of mobility by acquiring Cruise Automation, a self-driving vehicle startup. At the time, Cruise was developing hardware and software that would allow a vehicle to drive autonomously on the highway, and had been working on technology that would allow a vehicle to be fully autonomous. Please see our report Imagine 2025: The Cruise Opportunity. While Cruise is the company's highest profile initiative, GM has looked to AI for other areas of their business as well. For instance, with IBM they rolled out AI to their OnStar program, which gives them the capability of identifying information about the car and its surroundings. As an example, when fuel is low, the AI can route the vehicle to a nearby station and signal to the pump to activate and pay for the fuel.

Ford and AI

In 2017, Ford purchased a stake in Argo AI, a self-driving startup. Ford has since acquired other smaller mobility technology companies such as Autonomic and Transloc to develop its open Transportation Mobility Cloud platform and improve rider experience through dynamic routing capabilities. The team is focused not just on autonomous vehicles, but also on the development of personal mobility devices, drones and other robotics to service first/last mile – all driven by AI.

Tesla and AI

CEO Elon Musk has been vocal on AI and Tesla is using AI to help drive their autonomous efforts. This past spring, Tesla announced plans for a robo-taxi network through its FSD offering. The company is using images captured from cameras on its vehicles to develop a neural network for vehicles. Once running fully autonomously, the company plans to allow owners to put their vehicle into a fleet (with Tesla taking a cut) that passengers could summon through a ride sharing application.

Aptiv and AI

We continue to believe Aptiv is a leader and key enabler of autonomous driving. The company purchased self-driving outfit Ottomatika (a Carnegie Mellon spin-off involved in early DARPA autonomous challenges and winner of 2007 DARPA Urban Challenge) in 2015. In 2017, the company purchased nuTonomy, a leading developer of autonomous driving software solutions further strengthening their position in the global autonomous mobility market. While the autonomous mobility on-demand opportunity is still in its nascent phase, Aptiv expects initial driverless tests to occur by the end of 2020, expanded customer pickup in geofenced areas by 2022, increased scale as hardware becomes automotive grade in 2025 and the convergence between the mobility service solution and AD OEM solution by 2030. Management has indicated they believe Aptiv's autonomous driving revenue will be $500mm by 2025. At scale, the company expects 70%-80% of its autonomous mobility revenue to come from recurring revenue streams.

Veoneer and AI

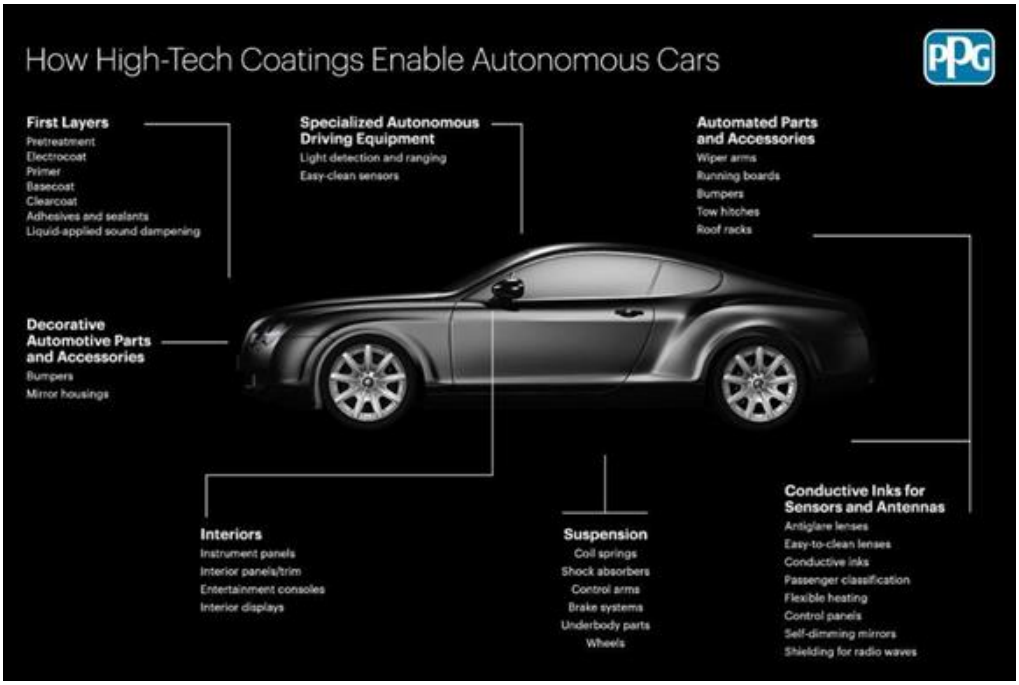
Veoneer is a pure-play company focused on safety electronics, ADAS and automated driving. Currently, Veoneer is focused on the L1-L2 active safety market. For instance, the company expects ~20% of vehicles to have L1-L2 technology, which rises to 55%-60% by 2025 (with L3 penetration rising from ~5% to ~20%). The company expects L4 penetration of ~10% in 2030. A large part of the Veoneer story is its Zenuity JV (with Volvo). Zenuity is focused on developing software for autonomous driving and ADAS applications. Veoneer is the exclusive supplier and distribution channel for the products sold to third parties, while Volvo will source directly from the JV.

Chemicals will have a role to play too…

We expect that the rise of autonomous vehicles will affect the entire automotive supply chain, including the paint color of the vehicle. The complexities of autonomous driving will require a new kind of paint and the major coatings companies have taken notice and are working on next generation paints and coating to fill the need. A major obstacle standing in the way of self-driving cars are the LIDAR sensors' inability to detect darker color that reflect less light back to the sensor (Darker colors absorb light, making it difficult for sensors to detect).

PPG is pioneering the development of paints and related coatings that will improve vehicle and infrastructure visibility to radar and light detection and ranging (LIDAR) sensors used in autonomous driving systems. This coating leverages commercially proven technology from PPG's aerospace business that functions in similar ways. Axalta is another example of company working with automotive manufacturers to develop a safer autonomous driving experience. AXTA recently announced a partnership with Karma Automotive to supply innovative and stylish design to the Karma electric vehicles. Further, its likely autonomous driving will be battery powered and to illustrate the growth in this market, the International Energy Administration forecast by 2025 there will be 50M electrical vehicles on the road, up from 3M in 2017. As autonomous vehicles become a reality, we believe this number will increase exponentially, and the auto manufacturers will need a smart paint.

Exhibit 14: High-tech coatings help to enable autonomous cars



Source: PPG filings

Autonomous Vehicles Powered by Lithium Batteries

Demand for lithium-ion batteries is growing at an exciting rate, driven by the global demand for electric vehicles, mobile devices and grid storage. We believe lithium batteries will play a key role in advancing EVs, autonomous driving and reducing air pollution. As the EV industry evolves, battery requirements would also need to evolve to address great safety needs and range specifications. Auto OEMs, suppliers and technology companies are going to need to collaborate in order to make autonomous vehicles a reality. These ambitious projects require the work of the collective minds and expertise to be completed. This is why we like companies such as Albemarle, which embraces the opportunity to build mutually beneficial relationships with business partners and local communities. As the next generation of autonomous driving and AI capabilities are developed, we would expect the chemical companies such as ALB and the coatings companies to have a higher degree of collaboration and exchange of ideas.

Our view is that artificial intelligence could have a major impact on the transportation industry and we note that most attention surrounds the effect of autonomous vehicles and the disruptive impact that they could have. However, we believe that there are other applications of AI that require less of a technological “leap”, such as preventative maintenance applications, that could favorably affect the industry. We think that AI could potentially have the largest impact on the trucking industry via autonomous trucks but we see trucking as having the highest degree of challenges to overcome – driverless trucks are likely to encounter regulatory hurdles and we think that driverless trucks would also have difficultly operating on current road infrastructure. We note that we do not expect driverless trucks to replace a significant amount of rail volumes on current road infrastructure. On the other hand, we see the impact from AI as being more significant and more applicable to the rails reflecting margin enhancement opportunities.

Autonomous Trucks

We believe that Autonomous Trucks have the potential to have a profound impact on the transportation industry by improving utilization, lowering costs, as well as increasing safety. Our view is that fully autonomous trucks, while still facing technological and regulatory hurdles, could disrupt the industry over the next 5-10 years if successfully put onto the roads. We would expect this evolution to happen first via platooning, second via partially autonomous trucks, and finally via fully autonomous trucks. In this section, we will discuss how the autonomous truck evolution could occur and the impact that we believe it may have on profitably in the industry. We expect that companies focused on technology and companies that are able to build scale will emerge the winners as AI disrupts the industry.

We believe that driver assisted platooning is the first step towards fully autonomous trucks. Driver assisted platooning involves using wireless communication between two or more trucks, allowing them to follow closely behind one another (see Exhibit 15). The driver of the first truck in a platoon acts as the leader, with the vehicles behind reacting and adapting to changes in its movement. The drivers of the trucks in the back of the platoon remain in their respective trucks without actively controlling the vehicle but can decide when to leave the platoon. Platoons save fuel costs as the lead truck breaks the wind and creates a "wind tunnel", which results in less wind resistance for the trucks in the back of the platoon thereby reducing fuel consumption and costs – a study by Transport Canada showed a range of fuel savings between 4-18%, depending on the platoon formation and other factors. Additionally, platoons are safer because trucks in the back of the platoon break both automatically and immediately. Our view is that platooning would encounter fewer regulatory hurdles and present less safety risk than fully autonomous trucks but are likely to only result in incremental operating improvements.

We expect that partially autonomous trucks and driverless platooning will follow. As autonomous driving technology advances, we anticipate that trucks could begin to drive autonomously under controlled conditions. This could involve driverless platooning where only the first truck in the platoon is controlled by a person and autonomous trucks driving under controlled conditions, such as on straight-line highways. Our view is that these developments will be safer and less likely to encounter regulatory hurdles when compared to fully autonomous trucks driving on all roads and in all conditions (see Exhibit 15). We believe that these advancements would be more disruptive than driver assisted platooning because labor costs would decrease and truck capacity would increase as utilization is no longer constrained by drivers (i.e. drivers only being able to drive a certain number of hours per day). However, we expect that these potential cost savings and capacity gains would most likely be passed on to customers via lower shipping costs as opposed to captured by trucking companies reflecting the competitiveness and fragmented nature of the industry.

Fully autonomous trucks may eventually dominate the roads. Looking longer term we believe fully autonomous trucks could eventually dominate the industry. If successfully implemented, the benefits to trucking companies would be significantly lower labor costs (no drivers) as well as much higher asset utilization as trucks are not constrained by the amount of time drivers can spend behind the wheel. We believe that this would result in much higher trucking capacity and in lower transportation costs throughout the industry. Our view is that the industry would consolidate as larger players would be better able to make the technological investments required to move to autonomous fleets while less profitable and smaller competitors would get left behind. It will be interesting to see if autonomous driving companies (i.e., Waymo) build out their own fleets or license out their technology to current industry participants - we expect this decision to have profound implications.

Exhibit 15: The expected evolution of driverless trucks

Illustration of trucks platooning

Waymo truck driving in controlled conditions

Source: ResearchGate, Waymo company reports

Cost savings most likely to be passed on to shippers. Important questions for investors to contemplate are 1) what effect will self-driving trucks have on the transportation industry and 2) will incumbent trucking firms capture the cost savings associated with lower labor costs or will new firms enter and disrupt the industry? As we noted above, we believe that trucking firms may not fully benefit from the cost savings associated with autonomous trucks and that savings are most likely to be passed on to the shippers reflecting the competitive nature of the industry. However, determining the eventual winners and losers of the self-driving revolution is more difficult. On one hand, we note that Waymo, owned by Google's parent Alphabet and arguably the industry leader in autonomous driving, is building out its own ride-hailing fleet, which suggests that it could do the same in trucking. At this point though, our view is that they will not do this as relationships with shippers and the capital intensity required make doing so more complex and less profitable vs. licensing the software. As such, we believe that Waymo would be more likely to license their software similar to how Alphabet licenses Android software to cell phone manufacturers. On the other hand, incumbent firms could build out the technology themselves. We view this as less likely as self-driving firms have a significant, arguably insurmountable, head start – we note that Waymo has 10 million miles in real world driving and 10 billion in simulated driving. Additionally, we do not think that the incumbent firms have the technological know-how or the budgets to effectively compete – Uber spent $457MM in 2018 investing in autonomous vehicles as per Uber's S-1.

Autonomous Trucks may put pricing pressure on the railroads. As we discussed above, our view is that autonomous trucks could increase capacity and significantly reduce labor costs in the trucking industry and therefore reduce shipping costs. We believe that if autonomous trucks ever dominate the roads, a big question mark in our view, this could put pressure on pricing in the rail industry, especially in certain intermodal lanes that compete more closely with truck for share – we believe that the bulk and merchandise franchises of the railroads would be less affected. However, as we explain in more detail below, we also think the railroads have significant opportunity as it relates to artificial intelligence.

We believe that digital freight brokerages could increase information transparency. The freight brokerage industry is undergoing a transformation as both Amazon and Uber have established digital freight brokerages. Uber is targeting small shippers that it believes are underserved by technology and most likely to benefit from an automated self-serve tool – we note that revenue has increased 10x Y/Y and that they have contracted with over 400,000 drivers as per Uber's Q1 and Q2 releases. We also note that incumbents are investing heavily in digitization with C.H. Robinson planning to increase their technology spend to $200MM per year for the next 5 years. Our view is that digital freight brokers would increase pricing

transparency in the industry and further increase price competition. However, we believe that this would result in service becoming even more important for shippers and a key differentiator for incumbent trucking firms.

TrAIns and AIrlines

Over the next few pages we discuss artificial intelligences' impact on train and airline transportation.

We think that artificial intelligence is going to affect the railroad but our view is that it will result in incremental margin improvement as opposed to having a transformative impact. We believe that autonomous trains will be a positive but we note that labor makes up a small percentage of the costs required to operate a train so the benefit is likely to be smaller than compared to truck. Our view is that the main benefit from AI on the railroads relates to maintenance from less headcount, more accurate inspections of track and trains as well as prevention of catastrophic events such as derailments.

Automated Inspection Portals (AIPs) will improve the speed and accuracy of train inspections. At CNR's recent Investor Day (June 2019) we had the opportunity to see firsthand some of CNR's planned Artificial Intelligence applications. AIPs, which inspect trains as they transport goods in the normal course of operations, are already in use and are able to inspect trains 120x faster than a human inspector and are not affected by weather conditions or fatigue – thereby making them more accurate as well. Our view is that further AIP implementation will reduce costs associated with inspection as well as decrease expenses associated with train disruptions. Further, the savings (financial, socially and environmentally) from catching possible catastrophic defects that would have otherwise gone undetected are potentially quite meaningful. We note that CNR expects $200-400MM in savings through 2022, which gives investors context as to the significance of the potential gains.

Exhibit 16: The advantages of AIP vs. manual inspection

Metric	Automated Inspection Portal	Manual Track Inspection
Accuracy	Machine learning algorithm that gets better over time	Human that is prone to fatigue
Working hours	24/7	8 hour shifts
External factors	Operates with the same efficiency in all conditions	Affected by cold, rain, snow, etc.
Speed	Can inspect 120x as fast	Inspects 1 car every 2 minutes
Inspection Area	Whole car	Eye level and below (i.e. inspector cannot inspect top of car)
Capacity	Not affected; trains travel at operating speed (60 mph) during inspection	Reduced capacity; inspection occurs while car is stationary in the yard
Data	Collected and submitted to Visual Analytics Team	n.a.
Cost	~3-$4MM per portal	Salaried employees
Safety	Very safe; limited human involvement	Can be dangerous

Source: CNR company reports

Exhibit 17: Our tour of CN's Automated Inspection Portal

Live look at the AIP in action (train was travelling at operating speed)

An inside look at the technology of an AIP

Source: RBC Capital Markets

We expect Autonomous Track Inspection to improve safety, reliability and efficiency. We believe that Autonomous Track Inspection, which inspects track via cameras attached to trains in the normal course of operations, will increase capacity and decrease costs on the railroad. Currently during track inspections, trains must reduce speed and sections of track must be shut down as workers conduct inspections, thereby reducing fluidity. In contrast, Autonomous Track Inspection, according to CNR, can inspect trains while they are travelling at operating speed (~60 mph) compared to traditional methods which allow for 40-60 miles of inspection per day. In addition, we believe this technology has the potential to prevent derailments and other major disruptions as problem areas of track can be repaired prior to causing issues. We also note that these machines are faster as well as allow for the collection of data that we expect will result in incremental improvements to the railroads' operating efficiency.

Autonomous trains likely to have smaller impact on railroad operations vs. truck. We believe that technology is already available for autonomous trains and note that many subway systems (i.e. Singapore) and certain Rio Tinto iron ore trains in Australia are already autonomous. However, while the technology is available, we would expect the railroads to encounter significant push-back from their unions should they try and implement. Additionally, we do not expect autonomous trains to have as large an impact on the railroad industry as autonomous trucks could have on the trucking industry. We note the labor costs associated with operating a train are much less as a percentage of revenue compared to operating a truck. However, we note that rail capacity would increase as trains would not have to stop for crew changes.

Benefits from technology are likely to result in improved margins at the railroads. As we discussed above, we believe that operating efficiencies from technology in the trucking industry are likely to be passed on to shippers reflecting the fragmented and competitive nature of the industry. However, the railroad industry can be characterized as an oligopoly with limited and rational competition so we expect that technological benefits are more likely to be realized by the rails as opposed to being passed on to shippers via lower prices. Our view is that technology will lower costs resulting from operational improvements as well as increase prices due to better service. We expect the favorable characteristics of the rail industry to drive step-function increases in free cash flow (and shareholder returns) as technological advances are implemented.

Autonomous Ports could increase throughput

North American ports stand to benefit from automation; however, unions will likely resist. Automated Port technology, such as autonomous straddle carriers, automated guided vehicles, and automated stacking cranes, is slowly being incorporated into North American ports. Currently, two North American ports, Middle Harbor in Long Beach and TraPac in Los Angeles, have fully automated yard operations. We believe Automated Port functionality could act as a tailwind to volumes at the railways as containers are handled more efficiently and may result in improved service reliability thereby enhancing fluidity. However, we anticipate that ports will continue to encounter significant resistance from their unions regarding automation, a trend seen recently in Vancouver during contract negotiations between the port and the union representing Longshoremen. Going forward, we expect automation adoption at the North American ports to improve capacity and service at the ports thereby benefitting the railroads and trucking companies operating out of them.

Artificial Intelligence use in AIrlines

AI is being explored and integrated across the aviation industry in multiple areas, including customer service & check-in, aircraft maintenance, airport development, and pilotless flying.

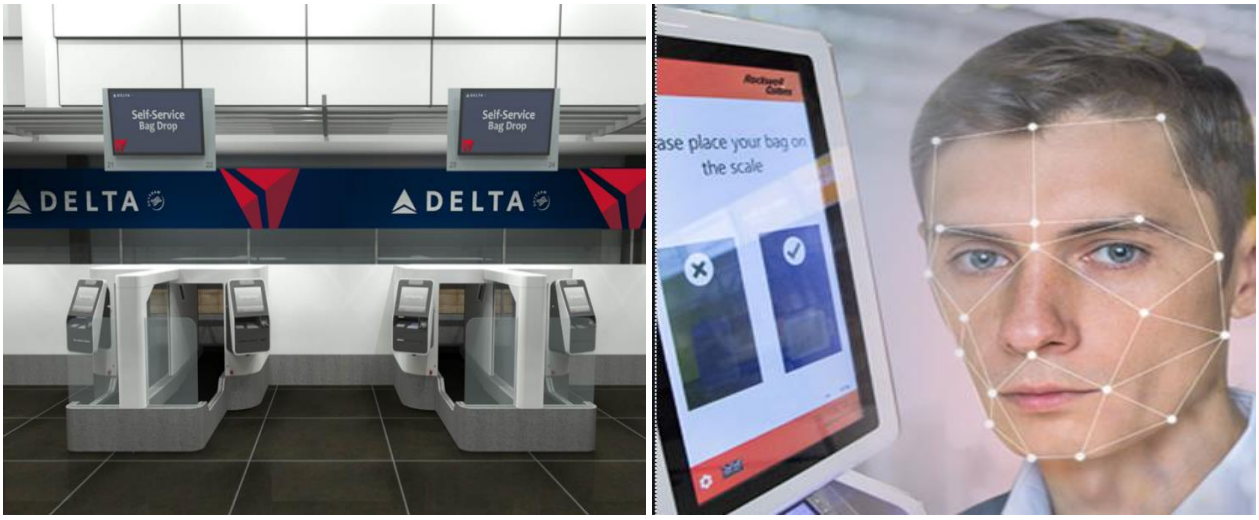
Customer service & check-in

Facial recognition in airport security. Airlines across the globe have been experimenting with early phases of using facial recognition technology at airport check-in counters. At the counter and security line, a camera scans the face of the traveler, creating a biometric template based on the passenger's photograph, and sends the photo to a remote system that matches it to a stored copy of the actual passport photo. The template is a set of measurements of the size and shape of features, like eyes, and the distance between features, like your nose and upper lip. The system compares that template to a preloaded gallery of passenger photos, pulled from passports and other sources.

Technology already in use by the world's largest airlines. The technology is already widely used across the U.S. through the Customs and Border Protection ("CBP") program, called Biometric Exit. The program includes a face-matching system and is used at departure gates in 17 airports in the U.S. Full implementation is expected as soon as 2021, when the agency plans to have the system scan 97 percent of all outbound international travelers. Airlines including JetBlue, British Airways and Delta, have already partnered with the CBP to implement the system, and the Transportation Security Agency is also testing facial recognition cameras throughout airports. Outside North America, Narita International Airport in Japan is rolling out facial recognition boarding facilities at several airports throughout 2019, China's Hongqiao International Airport is also using facial recognition for security screening, and is in the process of expanding to a full curb-to-gate facial recognition system. London's Heathrow plans to start testing an end-to-end facial recognition program next year. We ultimately expect facial recognition to become the norm across the globe, as software improves accuracy, speed and efficiency. We envision facial recognition to replace the need to manually check paper travel documents by an airline representative. We therefore expect the trend towards facial recognition to lower airline costs through lower personnel requirements and increased airport efficiency.

Biometric based bag-check in. Certain airlines are also experimenting with biometric-based self-service drop off desks, allowing customers to easily check their own bags. The machines are equipped with facial recognition technology to match customers with their passport photos through identification verification. For instance, Delta introduced four self-service bag drop machines at Minneapolis International Airport in 2017. As mentioned above, we view the integration of facial-recognition technology across the customer service spectrum to be a way for airlines to streamline processes and improve efficiency - studies have found that self-service bag drops have the potential to process twice as many customers per hour. Therefore, we expect this type of automated interaction is likely to become the norm across airports globally.

Exhibit 18: Facial recognition is being used across U.S. airports for bag drops



Source: Delta Website, Airport Review

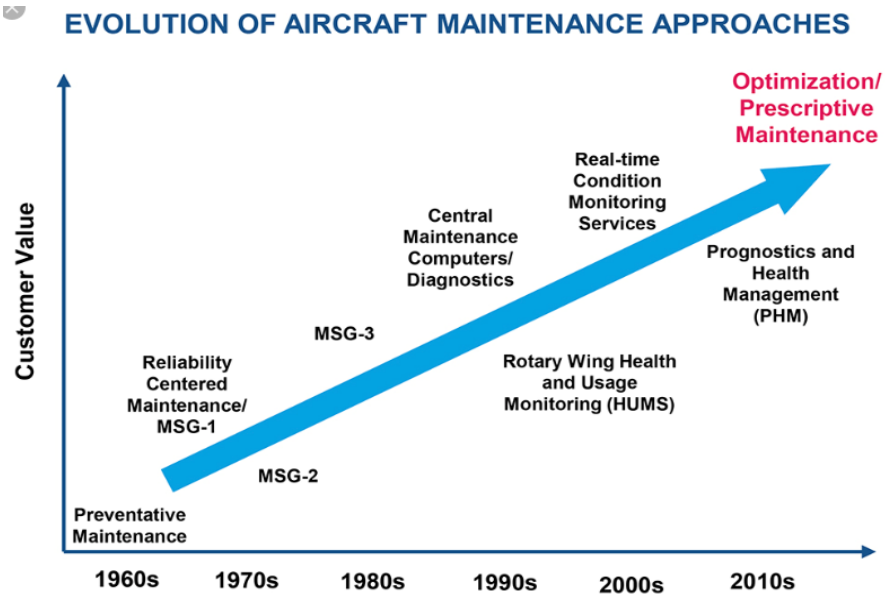
AI Assistant integration. Many airlines have developed skills for AI assistants like Alexa, Siri and Google Assistant. Devices with these assistants use machine learning and artificial intelligence to respond to spoken questions about such things as fare quotes and the status of flights. Travelers can simply ask for the status of their flight, provide fare quotes, and which baggage carousel to go to pick up baggage after a flight. Additionally, AI assistants can provide general answers about a mobile app, required travel documents, TSA pre-check availability and certain ticket policies. For instance, Air Canada has become the first Canadian airline to partner with Alexa, allowing Air Canada customers to obtain travel information using their Alexa devices. We expect these capabilities to expand across airlines and lessen the requirements for customer service personnel.

Aircraft Maintenance

MRO moves towards Predictive Maintenance. Artificial intelligence is altering the Maintenance, Repair and Operations (MRO) strategies of airlines. Traditionally, airline mechanics were tasked with aggregating and analyzing the raw data transmitted by aircraft in order to diagnose a problem. The relevant experts would then be brought in and appropriate parts would be ordered, which generally leads to a period of 'unplanned maintenance' for the aircraft, which is very costly for airlines. PWC estimated in 2017 that in the US alone, the cost of maintenance related delays for airlines was well over $0.5B. Almost a third of total delay time is due to unplanned maintenance.

AI is allowing airlines to 'predict' when maintenance should be scheduled. Recent advancements in AI have led to tools in the form of intelligent agents for data modelling and simulation to the use of cognitive computing. Rather than the technicians aggregating and analyzing the data themselves, AI tools could provide output which includes a diagnosis, the required parts, and the necessary tooling and routing of the aircraft. This way, the experts are focused on responding to alerts where their specialized skills are needed, rather than a single failure alert. This is evolving into the use of predictive data analytics, an important functionality that will allow an airline to predict component failures with a planning period. If a maintenance order can be predicted with enough lead time, the unplanned maintenance order can turn into a planned one and would be less costly. This can also include heavy maintenance plans, while simultaneously coordinating with third-party suppliers, fleet-wide modification plans and upgrade schedules.

Exhibit 19: Aircraft maintenance is moving towards a predictive analytical approach



Source: Aviation Today, KLM

EasyJet manages its growing fleet using an AI powered tool. The push for an AI solution is partially a reflection of the costs of managing a growing fleet, with a wider variety of aircraft types. As an example, EasyJet is adopting AI tools for predictive maintenance using a London-based start-up Aerogility's decision support tool. This software represents every aircraft in the fleet, including individual software parts and available upgrades and modifications. Aerogility's web-based application and SQL database are capable of simulating output data, including analytics, schedules, and order logs. EasyJet has been using the software since December 2017, but continuously upgrades capabilities, which now include forecasting of engine shop visits and landing gear overhauls. We ultimately view predictive maintenance as a way for airlines to avoid costly maintenance delays, improve scheduling efficiency and improve the customer experience. This is all very positive, but will require a period of capital investment as the technology is developed and tested. Airlines that lead in terms of investment will likely have an advantage in the years to come.

Pilotless planes

Airline technology has improved dramatically over the years. New materials are making planes lighter and more comfortable, while new technology is making flying more quiet, faster and cheaper.

Despite a few recent events, better avionics are making flying generally safer, and could eventually lead to a time when most aircraft will no longer require a pilot. In a recent article, the Economist points out that pilotless planes are nothing new in the military – the armed forces have been embracing pilotless planes for a couple of decades, including surveillance and missile-carrying drones. Within the next few years, we could also see robot military helicopters introduced and pilotless fighter jets starting to emerge. Cargo aircraft, both military and civilian, could be robotized as well.

Pilotless aircraft, while positive for airlines, are still a ways away. Both Airbus and Boeing are preparing for at least a single-pilot commercial aviation world, which would require not only a reliable flight management system, but also a re-design of the cockpit for one-person operation. Both firms are now testing simulators of such cockpits. This is indeed very appealing for airlines – a study released in 2018 by a competitor bank suggests that moving to single-

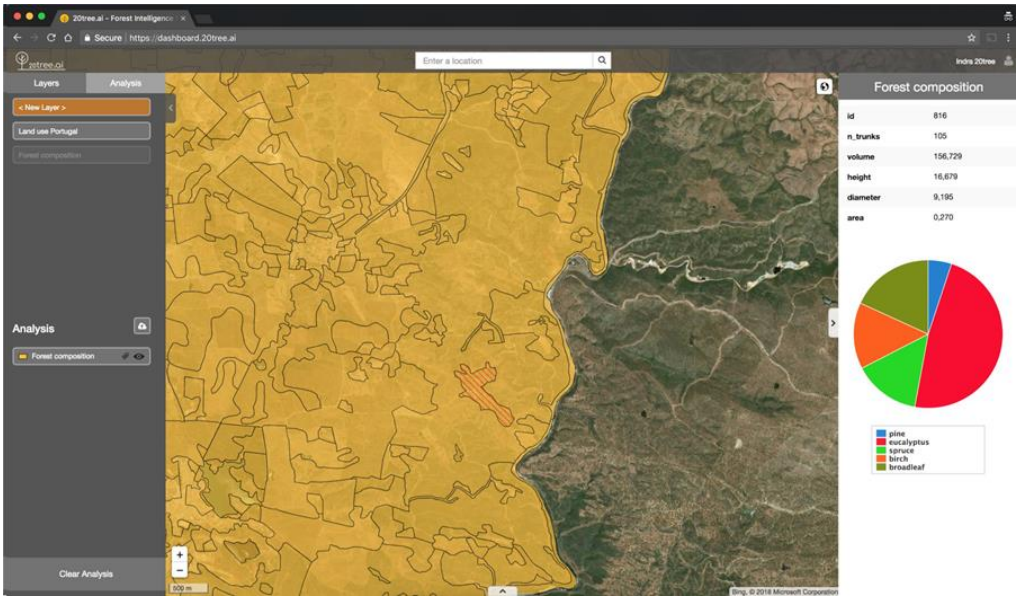
pilot operation could save the world's airlines $15B a year. Going fully pilotless increases that number to $35B. While this sounds promising, we are of the view that the move towards pilotless, or even one pilot planes, will take many years to evolve. From a regulatory perspective, the industry still has to make significant progress, and pilots will likely sit in the cockpit long after they are no longer needed for reassurance to the public.

Redefining Forest Management with AI and Deep Neural Networks

The end-uses of AI technology extend beyond manufacturing. For timberland owners, artificial intelligence could be transformative to forest management practices and timber asset valuation. The traditional methods of timberland management involve very manual surveillance and data collection, which could be disrupted by the emergence of artificial intelligence and ultra-high-quality satellite imagery / radar data that is capable of monitoring entire forests in an instant.

A Portugal-based startup, *20tree.ai*, uses NVIDIA GPUs to process ~100TB of forest satellite data daily, in order to train deep neural networks. The deep neural networks can draw insights into forest health that would be invisible to the human eye. Clients of *20tree.ai* can track forest disturbance, drought conditions and other variables in a matter of minutes. This technology can help enable faster, better decisions that improve sustainability.

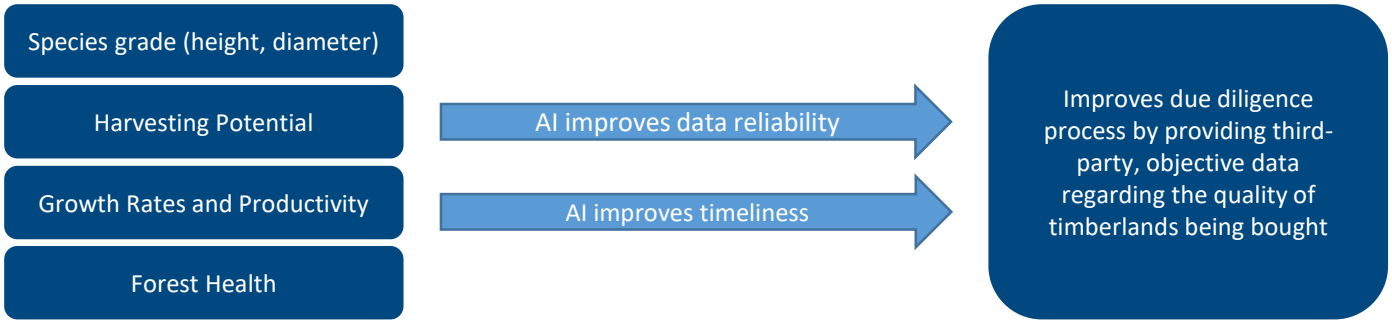
Exhibit 20: 20tree.ai's dashboards show forest composition data from satellite feeds



Source: 20tree.ai

AI applications in forest management range beyond improving sustainability, and can help with timber valuation. Stora Enso uses 20tree.ai to analyze factors like tree species, height and diameter, growth and productivity, as well as harvesting potential. With faster and more accurate information, AI helps firms like Stora Enso determine a fair valuation for timber properties. We believe AI driven technology will be critical to managing Timber properties in the long-term, and will provide a data-driven, objective approach to transaction valuation.

Exhibit 21: AI can help improve how land is valued by providing up-to-date analysis of timberlands



Source: NVIDIA, 20tree.ai, RBC Capital Markets

They call me trashbot

Robotic implementation continues to grow across applications in the waste sector, including automated trash collection and recyclable material sorting. Robotics with enhanced optical sensors have the ability to automate the sorting process and extraction of recyclable materials from the waste stream through the use of machine learning or artificial intelligence. Use of robotics and AI will continue to gain traction as the need to improve the economics of recyclable material extraction from the waste stream remains a key determining factor in providing recycling services. Machine learning can distinguish the features of different materials while avoiding the need for expensive spectral infrared sensors – further improved through AI. Going forward, we would expect these "trash-bots" to further embed themselves into the recycling operations of large waste companies – with a combined effect of both reducing overhead costs, improving employee safety, and increasing the yield and quality of recyclable material extraction from municipal and commercial solid waste.

Exhibit 22: Robotic arms and optical sensors are a mainstay in next-gen recycling facilities

Source: Waste Management Review

Doing the heavy lifting

Improving the safety of both employees and the general population remains a key focus for the waste industry. Side-arm loading technologies have been around for many years; however, there continues to be a push from the waste majors to implement the technology across operations. Side-arm loaders allow the vehicle to be operated by just one employee (as opposed to 2-3 in a conventional garbage vehicle), which serves to reduce headcount and maximize asset utilization. In addition, no operators are required to physically leave the vehicle to collect waste, thereby greatly enhancing the safety profile and lowering the incident rates of waste company's employees. We believe increased use of automation and AI to perform tasks previously completed physically by employees will continue to gain traction in the industry across business lines and segments.

Exhibit 23: Side-arm loaders remain a key driver of safety and improved collection economics

Source: Waste360

Providing an invisible hand

As vehicle technology continues to evolve; we think the next step in the evolution will involve the use of autonomous driving – requiring zero employees to physically operate the vehicle. In fact, the truck could be operated from a remote location, much like an individual would use a controller during a video game. Waste Management CEO Jim Fish believes that the company will have an autonomous truck in their fleet within the next 5-10 years; management teams at the other public waste majors are slightly less optimistic this technology will be available within the next decade. However long it takes for autonomous trucks to enter the fleets of waste companies, we hold the belief that it is much more a matter of when the first truck will be operational. In the interim, the waste sector is implementing semi-autonomous vehicles that now include collision and telematics sensors that are driving safety related incident rates to new lows.

Exhibit 24: Semi-autonomous garbage trucks are improving safety related incident rates while full autonomy is being developed

Source: Preco Electronics and Sensors, MACK Truck

A more productive route

With GPS and route optimization software, waste companies can now effectively manage transportation costs. Software applications can generate efficient vehicle routes over a street network with savings realized by reducing miles driven, hours spent, reduction in the number of vehicles required and reduction in total disposal cost. This is proving to be a significant savings enhancement for the majors with transportation a major frictional cost for the industry. Route optimization software also provides for other opportunities like dynamic dispatching, real-time vehicle tracking and planned vs. actual comparisons, which we see only improving and becoming more wide-spread across the waste industry as AI is further incorporated into the decision-making process of operations.

Next wave of truck technology set to include in-cab cameras & real-time sensors

In-truck tablets, cameras, sensors, and integrated cloud-based software are beginning to move beyond baseline GPS tracking to include the positioning of solid waste collection bins, road networks, population density, schedules, and truck capacities. Newer technologies are able to, through the use of sensors and cameras, assess the contents of a waste load in the back of a truck and determine how full the container is. While this technology may be a few years away from making it into the fleets of the waste majors, we think it could have the potential to lower contamination levels in the waste stream, improve incident rates, and increase route efficiency.

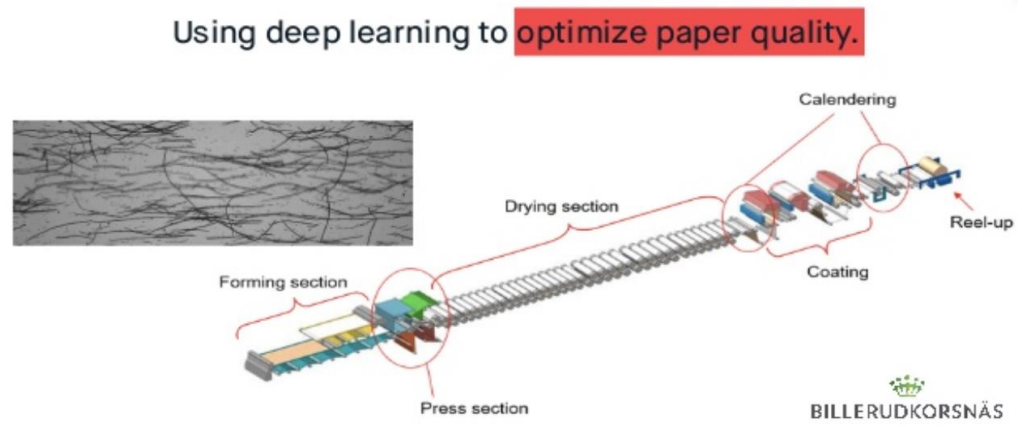
Seeing the forest for the trees

Optimizing paper and pulp manufacturing

Since large-scale adoption of mechanical pulping (1840s) and kraft pulping (1870s), innovation in pulp and paper manufacturing has been evolutionary, not revolutionary. Traditionally, operators have sought to increase operating efficiencies by modernizing mill equipment to enhance pulp yields and improve energy costs. However, with an abundance of data generated during the manufacturing process, pulp and paper producers are using AI and deep learning networks to power the next leap of productivity, quality and automation to unlock incremental efficiencies that could help bring producers down the cost curve.

For example, Swedish pulp and paper manufacturer BillerudKorsnäs aims to harness AI and machine learning to optimize throughput and perfect product quality. In collaboration with PulpEye, a Measurement Technology Company, and Peltarion, a Deep Learning Technology Company, BillerudKorsnäs can **1)** process fiber data from a paperboard machine and find measures to improve properties like density and strength; **2)** render accurate predictions of quality measurements; and, **3)** automatically adjust fiber inputs to assist operators and reduce operating costs.

Exhibit 25: AI's continuous learning properties help operators optimize manufacturing



Source: BillerudKorsnäs, RBC Capital Markets

More efficient pricing in the housing market

Currently, pricing a house is part art and part science, but there is still a large art component to it. Both real estate agents and homeowners use a combination of comparable houses, strength of the market, and feel to set a price. It is a delicate balancing act between drawing enough interest and maximizing the price. Should you list at $359k or $369k? Well $369k is obviously better for the seller, but what if the higher price doesn't draw interest? These decisions are largely driven by the real estate agent's experience and feel for the market, but AI can potentially dial in a more optimal level.

Some homebuilders such as Lennar have internal real-time pricing models and Zillow's Zestimate is a widely used attempt to apply data to home pricing at a large scale. Real estate agents may be de-emphasized as these systems progress in their ability to more accurately price homes and consumers become more comfortable with them, saving costs for both the buyer and seller. Multiple companies (most notably Zillow, Opendoor, and Redfin) have already begun to use big data to alter the relationship with realtors by buying homes directly from sellers and flipping them quickly for a profit (known collectively as iBuyers). These programs have been slowly rolling out across the country as they become more refined with larger datasets. Notwithstanding the very real question of the sustainability of capital-intensive iBuyer platforms through-cycle, we believe that Artificial Intelligence likely becomes more of a mainstay in the home pricing industry. The housing market is filled with data points on what has and what hasn't sold, different listing characteristics and even images, a perfect environment in which to train AI. A fully trained AI system would be able to accurately price a home, hitting the perfect balance between drawing interest and maximizing sales price. The financial and emotional significance of housing transactions suggests a personal touch will still be needed, but the ways in which we interact with and what we rely on agents for may very well continue to change as AI becomes more prominent.

In this AI-driven world, a homebuilder could also determine a more precise amount of discount needed to get a potential homebuyer to sign, while maximizing its own return. Taking that a step further, these AI systems could predict which markets are heating up or cooling and could use this to direct builders' land spend for future communities. Quality land purchases are one of the most important determinants of a homebuilder's profit, so any advantage in land spend could yield significant returns.

Real time and predictive reaction to shifting consumer preferences

Whether it be the vibrant patterns and colors of the '70s, the pastel colors of the '80s or today's sleek and modern look, consumer tastes are constantly evolving. One of the hallmarks of artificial intelligence is pattern recognition and then ultimately prediction. As AI continues to develop, companies should be able to not only identify ongoing shifts in consumer trends, but also to proactively predict these trends. This would enable those who best employ AI to capture market share and make higher-return capital investments. Conversely, those who fail to adapt could see once-strong market positions and profitability decline. MHK serves as a recent cautionary tale of the potential for evolving consumer tastes and technology to quickly erode an incumbent's profits. Luxury vinyl flooring (LVT) – which is dominated by the Chinese – has rapidly taken share within flooring markets, pressuring profitability in MHK's other core flooring businesses as well as creating operational inefficiencies as it tries to catch up and build out manufacturing capacity.

Predictive maintenance and working capital management

Another potential benefit of AI is in predictive maintenance, both for homeowners and manufacturing operations. Currently most home maintenance is very reactive (and expensive) when something breaks. AI could be implemented throughout the house to be able to predict failures in electrical, plumbing, HVAC, etc. These predictive features would not only be a benefit for the consumer, but would also allow manufacturers to drive higher priced and ideally higher margin products. Manufacturers may also be able to ultimately use predictive maintenance to add an ongoing service revenue component, which could supplement the current model of a product sale with a warranty addition. These same predictive maintenance tools can also be used within a company's manufacturing facilities, helping to predict which machines are starting to break down in order to proactively avoid and manage production downtime, and potentially enable cheaper repairs, ultimately boosting productivity.

Companies could also use AI to more accurately match production schedules to demand trends, which in turn would allow them to better manage working capital.

Drones & Unmanned vehicles to reduce costs and execution risk

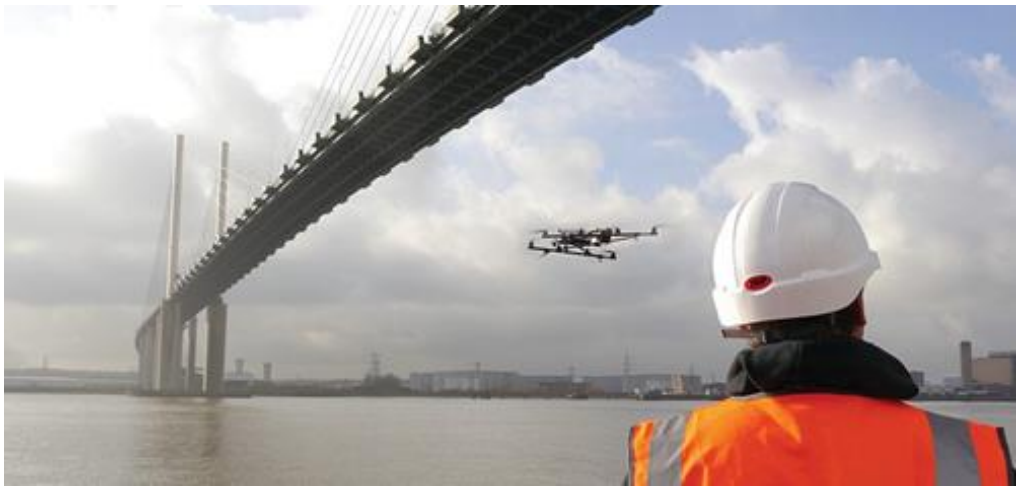
Drones, or unmanned vehicles, which rely on artificial intelligence and autonomous driving technology are being used in a variety of E&C tasks including surveying, mapping and inspecting in much less time and with less labor. Because of their small size and weight, unmanned vehicles can usually be loaded, deployed and operated by one person. For example, a single surveyor with a drone mapped an entire Manitoba dam construction site, compared with the 14 people normally needed for a land-based survey. In addition, it may usually be cheaper to survey sites using an unmanned vehicle vs. an aircraft (especially in remote locations). For instance, to get an aircraft from Edmonton to a northern site may cost $10K, while a drone transported from a field office can do the same job for <$3K. Drones also allow for potentially contaminated or hard-to-reach areas to be accurately mapped or monitored, thus creating opportunities in areas that were potentially deemed unfeasible in the past.

Predictive analytics to reduce project related execution risk

Drones have the potential to be used in conjunction with neural networks to collect real-time images and compare to the project plan autonomously (via the neural network). We see this having significant potential in the E&C sector as the technology would support improved accuracy and risk mitigation and therefore limit project execution risk. The technology has a predictive element to it which would allow project managers to receive real-time visual data around the progress at a project and would therefore contribute to more informed decision making. Early detection around potential cost overruns would likely result in fewer surprises during the late stages of a project as the artificial intelligence would keep the contractor, subcontractors, and client updated throughout the duration of the project. We see drone and neural network based technology driving potential operational improvements in the following areas:

- Improved quality of the final product;
- Greater safety;
- Reduced time to completion;
- Lower costs through labor optimization;
- Early identification of potential cost-overruns; and
- Fewer discrepancies amongst stakeholders.

Exhibit 26: A drone flying over a construction site



Source: RBC Capital Markets estimates, Company reports

Streamlining staffing capabilities

Leveraging AI can help streamline historically cumbersome, time-consuming, and human-oriented tasks conducted by staffing companies, saving time and money and providing a better candidate and client experience with faster turnaround/time-to-hire.

Examples of AI use cases for staffing companies include:

Candidate-sourcing – We have seen early adoption of AI in candidate sourcing/screening and employer matching. The traditional recruiting method requires a human to examine each application and resume by hand, and manually determine if a candidate meets an employer's criteria. However, AI can make use of vast amounts of historical and real-time data to determine the efficiency of jobs ads across a range of considerations. With this information, AI can deliver automated micro-targeted ad placement to reach the most relevant potential candidates in the places they are most likely to be looking. Same time, staffing companies can use AI technology to screen their database of past applicants.

Candidate engagement – AI can learn a candidate's communication preferences (e.g., text or email, time of day the candidate is most likely to respond) and tailor outreach accordingly.

Client engagement – AI-powered tools help facilitate better interactions between staffing companies, their contractors and clients. Many traditional staffers have developed/are developing AI chatbots, smart scheduling platforms, and video interviewing interfaces.

Risks created with AI

In the same way AI could help streamline processes within staffing company operations, we believe it can also shrink certain addressable markets. We see risk to staffing companies that provide lower-skill workers (e.g. clerical roles, manual labor etc.), as the increasing use of AI enables the automation of low value, repetitive tasks with quicker and more accurate output.

A report published by Brookings Institute (2019) estimates that 25% of U.S. jobs have high exposure to automation risk (meaning 70%+ of their responsibilities could soon be replaced by current technology), with the most vulnerable including office administration, production, transportation, and food preparation. More insulated job categories include complex professional creative roles, technical roles with high educational requirements, and service work requiring a high degree of emotional/social intelligence.

As a result, we expect AI-driven displacement in the labor market will increasingly force staffing companies to anticipate/plan for the new types of jobs AI will create, while also managing exposure away from vulnerable skill sets into more resilient ones. Notably, Kforce is undergoing a shift within its finance and accounting staffing business, pivoting toward higher value skills and de-emphasizing areas it views as at risk.

Separately, increased utilization and affordability of cloud technology would help improve the competitiveness of smaller enterprises, and broaden their access to labor markets with the ability to employ similarly sophisticated AI/machine learning tools to find qualified talent. This advancement may serve to shift the balance of power between small businesses and staffing companies, where the latter has historically commanded higher prices and better margins relative to their larger enterprise customer base.

Theme II: The Calibrated and Augmented Self

The Calibrated and Augmented Self is the concept that the "average consumer" is vanishing as machine and quantum computing learn and predict behaviors, leading to hyper-personalized products and services, and the ability for mass customization with less friction. However, the Calibrated and Augmented Self will most likely come with privacy and ethical risks. We believe companies that can balance personalization expectations and privacy demands, with a clear stand on ethical boundaries, will be the best positioned to succeed.

What you need to know

"The Calibrated and Augmented Self" is the concept that everything in the future is personalized; a stark contrast to the mass production, consumer products, media and healthcare of yesterday. Over the past two decades, the proliferation of choice has trained customers to expect more goods and services that mirror their specific needs and preferences. Our dialogue with company c-suites indicates a majority of companies understand the power of mass customization, however, the means to do so in a profitable way has not existed—until now. Big data, artificial intelligence, and advancements in technology are now enabling products, services, and experiences to cater specifically to an individual customer with lower levels of friction (at a very basic level). As we move forward, we believe the convergence of 3-D printing, advanced automotive electronics and coatings, the bioengineering of crops, virtual reality and drones will all drive much more personalized and affordable offerings.

Key Calibrated and Augmented Self developments include:

3-D printing will play a role in creating custom products in all categories, perhaps conveniently in each consumer's home.

E-commerce driving increased price transparency, particularly around commoditized offerings, while also driving the growth of **on-box advertising** tailored to the recipient, and more bespoke designs to make unboxing experiences more memorable.

Bioengineered crops coming to a store near you? Scientists are using gene editing/CRISPR technology to alter plant size, make fruit larger with better nutritional value, delay/prevent crops from bruising/browning, and help make plants more resilient to bad weather/drought and pests

Advanced automotive cockpit electronics will create a personalized driving experience, including predictive behavior for an enhanced driving experience, and technological advancements in coatings could lead to a future with changeable car colors via smart paint.

Companies Highlighted: 3M, GE, Grainger, HD Supply, WESCO, Visteon, Faurecia, Waste Management, Republic Services, WestRock, International Paper, Amazon, Walmart

The disruptive forces of e-commerce and price transparency

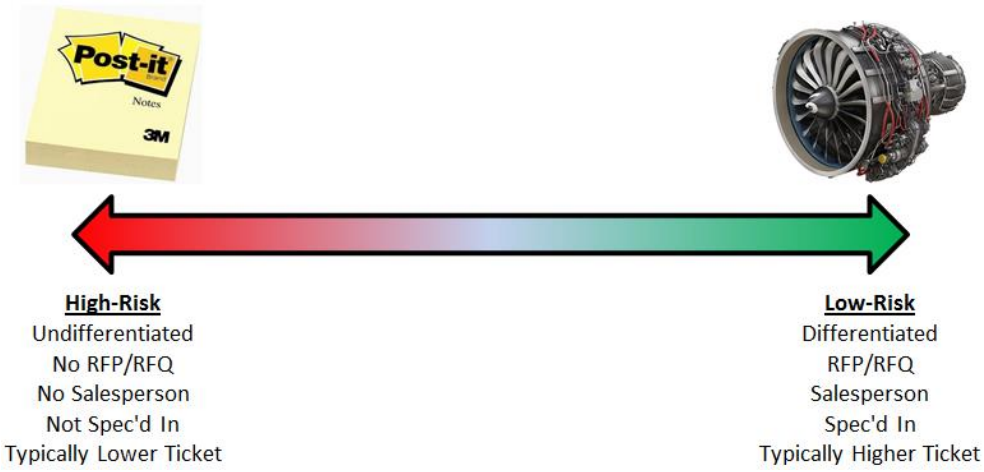
We expect the advent of comparison shopping and often times free shipping to remain disruptive secular trends. The accelerating adoption of ecommerce and online purchasing has been, and should continue to be, a disruptive force in the Multi-Industry sector. The proliferation of access to the internet at reasonable prices, whether through mobile or not, has spawned a generation of consumers accustomed to instant price checks and comparison shopping, with the goal to procure the best price. Furthermore, free shipping has become almost a necessary gating factor for purchases, adding another layer of costs to the producers compared to years ago when shipping could often times come with very healthy margins (assuming the producers also provided the shipping rather than utilizing third parties). As a result, prices paid by consumers seem to be continually migrating lower, and judging by the strong secular forces at play, we see no reason this abates in the near- to medium-term.

More retail-oriented companies, typically with lower average tickets, are the most at risk. The Multi-Industry sector is arguably the most diverse sector in terms of end market exposures with products ranging from 3M's Post-it notes to GE's jet engines. If we were to use these two examples as bookends of a spectrum of products, we would argue that online price transparency does not currently appear to be much of a threat to the lengthy contractual process related to selling jet engines. We also do not foresee this changing in the future as the high-priced and complex nature of the product does not lend itself to simple online pricing and sales. In contrast, more commoditized and typically lower-priced products, such as Post-it notes, are at risk.

- **Gross margins are a strong indicator of commoditization.** Given more-commoditized products face the greatest risk from price transparency/price competition due to the lack of product differentiation, these products tend to command the slimmest gross margin. We highlight that highly-engineered and differentiated products do not need to compete on price to sustain demand, and we consider these higher gross margin products as price-makers. Companies that are price takers, ones with lower gross margin and ones that lack market leadership, are at the greatest risk from price competition.

We believe the companies most at risk from ongoing secular pricing pressure are those offering commoditized products that do not require an RFP/RQP or any value-add salespeople or services.

Exhibit 27: Spectrum of Commoditized vs. Non-Commoditized Products



Source: RBC Capital Markets, Company reports

The industrial distributors are a "case study" of how ecommerce is disrupting industries that have been behind the curve in adapting to change. Looking back more than 10 years ago, many industrial distributors were in enviable positions to charge exorbitant prices for certain products as a result of the convenience they offered through their sprawling branch networks

for "need it now" products. For example, a contractor might have needed a small part to repair an HVAC system in a convenience store that day, and as a result of the timeliness of the issue and the low absolute cost of the part, the distributor could charge a hefty premium to the intrinsic value of the part. The dynamic is also exacerbated by the fact that most customers were likely using company credit cards where the costs were not a major issue for themselves personally. As efficient smartphones and quick free shipping have become widespread, the ability of industrial distributors to gouge customers on pricing has evaporated in many cases, especially for those that do not offer differentiated services. Grainger is likely the best example of the magnitude of the change as it has admittedly moved from being priced at roughly 30% premiums to peers on some products to closer to parity and has also cut its global branch network by roughly 40% vs. its peak.

- Industrial distributors are also generating more sales online, which tend to come with thinner margins, which could cause a negative feedback loop. In an effort to adapt to the new emphasis on ecommerce, industrial distributors have been forced to invest heavily in updating outdated inventory and ERP systems, and the percentage of sales coming from ecommerce is steadily growing. While this could provide a topline boost, it is somewhat of a catch-22 as the margin profile tends to be much thinner.
- **Emphasizing value-add services may be the only way to combat the trend.** The dynamic conjures up some parallels to what has happened to general brick and mortar retail in recent years, and we believe the main way industrial distributors can combat the threat is to offer differentiated value-add services.

Stock Implications

Should be a negative for the industrial distributors, though to varying degrees. We see Grainger as most at risk given its commoditized product offering with few value-add services. HD Supply and WESCO carry more differentiated services, which should help insulate their business models to a degree.

Could also be a negative for more consumer-focused manufacturers such as 3M. Among our coverage, 3M has the largest direct retail consumer exposure, though we point out that many of the companies in our coverage have businesses that could be impacted, such as small hand tools at Emerson and Fortive.

E-commerce to shape the future of delivery

The continued penetration of e-commerce has increased the demand requirements of the railroads, trucking companies and air freight carriers. The promise of expedited and same day delivery for a wide range of goods has forced retailers to de-centralize their distribution centers, providing opportunity for trucking companies willing to invest in the logistics and last-mile segments. We believe the trucking industry could see increased consolidation in order to obtain scale for these short haul routes. We also see the shift into e-commerce as an opportunity for both air freight carriers and railroads to pick up additional volumes. We view reliability of service as the differentiating success factor moving forward as delivery speed and dependability become increasingly more significant considerations in the purchasing decision of the end consumer.

Advertising at your doorstep

Containerboard has traditionally seen little innovation. Historically a highly fragmented market, supply has become more concentrated in recent years with the Top 5 producers controlling ~78% of the North American containerboard market (from ~43% in 1995). Today, International Paper and WestRock account for ~54% of effective industry capacity. Combined with steady demand growth driven by an extended period of economic growth and e-

commerce tailwinds, the industry has largely stabilized and been able to focus on longer-term investments. Below, we illustrate some key developments in corrugated packaging.

Exhibit 28: Key innovations in the corrugated packaging industry

Source: RBC Capital Markets

In 2015, one of the first major containerboard-based marketing campaigns was launched by Amazon to advertise the film *Minons*, which involved various printed boxes featuring movie characters. While novel, the concept did not immediately catch on in a big way. Contributors to the slow adoption include: **1)** the high cost of printing; **2)** the lack of technical capability to produce at scale; and, **3)** the growth of competing forms of advertising. We expect on-box advertising to grow over time as technical competence increases. For example, in January, Chevrolet announced a Silverado marketing campaign truck that will be featured on 7.1 million Amazon boxes (see below).

Farming is only going to get smarter (and more precise)

We expect on-farm tech adoption will continue as a means to improve productivity/operational efficiency, including the opportunity to supplant some existing manual tasks, for example via use of drones and autonomous equipment.

Precision agriculture is a key component of smart farming, and refers to the process of increasing the control and accuracy in farm operations. Data is at the epicenter; farmers collect data via sensors and use it to see what could be affecting crop yield, and how best to proceed with inputs like fertilizer and water. Over time, precision ag has evolved to include variable rate technology (VRT), which allows producers to adjust application of inputs based on particular field conditions, with controls on the rate, pattern and quantity of application as well as soil sampling, remote sensing and a broad range of other products given improvements in sensors, cloud-based systems, wireless connectivity, etc.

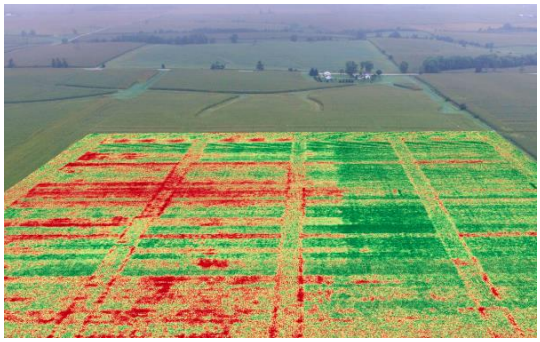
PwC estimates the market for drone-powered solutions in agriculture at $32.4 billion. According to an April 2018 Munich Reinsurance America survey of 269 farmers, 74% of respondents currently use or are considering adopting drones to assess, monitor, and manage their farm. A few concerns remain about the adoption of drones including privacy issues (23% of respondents) and cyber security concerns over data captured and transferred (20% of respondents), but we believe that these concerns will ease as drones become more socially accepted. Commercially, drones are already able to conduct soil and field analysis, as well as spray, monitor, and assess crops. Start-ups have also created drone-planting systems, but they are not yet commercially available. Drones are equipped with multispectral imaging that can help farmers monitor their fields with real time feedback providing analysis of crops and sense various plant and environmental characteristics. This allows for farmers to perform damage control if they detect pests, disease, or insufficient water/nitrogen.

While these drones should improve short-term yields, they'll also help in data collection; for example, identifying which phenotypes are most advantageous in crops. Companies that produce agricultural drones include Honeycorp, DJI, Parrot, and Precision Hawk, while various others produce software for drones, including Blue River. Most of the agricultural drone software on the market also tie together farm management software to deliver real-time analytics.

Exhibit 29: Agriculture Drones and Improved Yield Maps

Agriculture Drones

Improved Yield Maps



Source: DroneDeploy and DJI

Similarly, we expect farm machinery to continue to move toward autonomy reflecting need (fewer farm workers, productivity), although regulatory hurdles and gaining comfort with unmanned equipment remain potential challenges.

GPS guidance and assisted steering have been widely available in tractors, but self-driving systems have remained elusive. John Deere built its first autonomous navigation system in the 1990s in a partnership with NASA, and unveiled an autonomous tractor at CES 2019. CNH revealed a fully autonomous tractor concept in 2016 (in pilot programs) controlled from a computer or tablet remotely. The tractor uses GPS and satellite correction signals for guidance/recording/transmission of field data. It uses field boundary maps as the input then path planning software to plan the most efficient paths for specific tasks while automatically accounting for the width of tractor implements and adjusting as needed. CNH's tractor combines radar, LiDAR, and cameras to detect/avoid potential obstacles. CNH worked with Autonomous Solutions Incorporated (ASI) to develop and refine the concept tractor.

Exhibit 30: CNH Industrial Autonomous Tractor Concept

Source: CNH Industrial

Digital Agriculture: A Hungry Future

Digital agriculture attempts to use new and advanced technologies that can enable farmers and other stakeholders within the agriculture value chain to improve food production. Most of today's farmers make decisions regarding how much fertilizer or water to use based off rough estimates or experience. One of the perils of farming in this manner is that results are often not seen until harvest, at which point it is already too late to fix any problems. Digital Ag attempts to improve the decision-making process by combining several data points, such as weather and other external data points. The result for farmers and harvest is real time feedback and subsequently quick implementation of farming action through robotics and machinery. For example, PepsiCo has successfully reduced the amount of water input into their potato crop by 26% over the past 10 years. This has been done by locating the sources of water waste for re-use in irrigation. They also monitor the soil moisture, linked to weather forecast and set more efficient irrigation levels. Basically, making the farming process smarter, more accurate and less wasteful.

Exhibit 31: Digital Agriculture – the use of new and advanced technologies, integrated into a single system

Source: United Nations

Deere's 2017 acquisition of Blue River is a good example of potential for increased AI integration into the farm, in this case for crop spraying. Blue River uses computer vision, robotics, and machine learning/algorithms to help machines detect, identify and make decisions about each plant in a field (i.e., differentiate a plant from a weed). Relative to traditional/broad spraying application, the targeted technology has been shown to reduce chemical application by 90% when operating at a low speed, with Deere now looking to raise delivery speed capability and commercialize the technology including other equipment.

Likewise, AGCO's Precision Planting (acquired 2017) uses advanced sensing and measurement to increase yields. PrecisionMeter singulates a variety of seeds, eliminating skips and preventing doubles while the SeedSense monitor detects errors in down force, seed spacing, and singulation. Other products measure soil conditions including organic matter, moisture, temperature and residue levels to optimize planting decisions by creating a heat map of organic matter variability, allowing automatic application of different hybrids as it passes through variable areas of the field. For its part, Deere's 24-row ExactEmerge Intelligent Planter has 77 processors and over 7 million lines of code.

Bioengineering crops

A different angle involves bioengineering/adapting plants to improve growth efficiencies without introducing foreign matter. Gene editing/CRISPR can be used to alter plant size, make fruit larger with better nutritional value, delay/prevent crops from bruising/browning, and help make plants more resilient to bad weather/drought and pests (i.e., reduce pesticide use).

For example, scientists would historically introduce a new gene with a known function into a crop to achieve a desired outcome, or take a gene from an unrelated organism that exhibits a desired characteristic to replicate it in the plant. Now, using CRISPR technology to edit plant genomes, scientists have recently identified naturally occurring inefficiencies during photosynthesis.

A Science magazine article "Fixing photosynthetic inefficiencies" details where researchers at the University of Illinois engineered new pathways to make it easier for plants to eliminate a toxic compound occurring during photosynthesis, resulting in crops that produced 40% more biomass. While tested on tobacco plants, the plan is to expand the technique to soybeans and other crops.

Another example of engineered photosynthesis involves a more efficient process (C4 photosynthesis from C3) to increase crop yield. Although viable technology could be some time away, some estimates suggest it may be possible to increase rice yields by roughly half under the C4 scenario. Another benefit of C4 photosynthesis is that it is more efficient at higher temperatures, which could become more relevant in the context of global warming.

USDA does not regulate plants developed naturally and distinguishes between gene-edited/CRISPR and GMO. EU considers gene-edited/GMO the same.

Exhibit 32: Pending CRISPR Applications

Crop	Purpose of CRISPR Alteration	Current Stage
Apples	Non-browning when sliced	In stores
Cabbage	Improve growing patterns	Was produced and eaten prior to EU ruling
Coffee	Natural decaffeination to stop the expense of removing caffeine from coffee beans	Awaiting global regulatory approval
Corn	Non-transgenic improved crop yields	Awaiting regulatory approval for experiment
Wine (grapes)	Resist powdery mildew that affects sugar levels	Achieved proof of concept
Bananas	Fighting a deadly banana fungus and extending shelf life	Achieved proof of concept
Soybeans	Drought tolerance, seed oil composition improvement, and herbicide tolerance	Achieved proof of concept
Potatoes	Non-browning when sliced, longer shelf life	Achieved proof of concept
Cotton	Reduce the length and risk of loss during the cultivation process	Achieved proof of concept
Canola	Improve shatter resistance and yield losses	Achieved proof of concept
Papaya	Gain resiliency to new tropical pests and abiotic stresses	Achieved proof of concept
Squash, Gourds, Melon, Watermelon	Resistance to *Geminiviridae* virus that significantly decreases yields	Achieved proof of concept
Alfalfa	Change squamosa promoter binding protein gene to improve future breeding	Achieved proof of concept
Cassava	Resistance to Cassava Brown Streak Virus (CBSV), increase yield, and produce a waxy starch-like substance	Achieved proof of concept
Sugarbeet	Increased tolerance to biotic and abiotic stresses, enhance tolerance to salt	Achieved proof of concept

Source: Synthego

Corteva Agriscience is a good example of a company that is using technology to make the agriculture process smarter and more efficient. Through their proprietary software, CTVA allows farmers to gain insights from field-level data and better manage operations through customized predictive insights. Also, in an example of cross industry collaboration, CTVA is using CRISPR technology to grow more food that is healthier for people and the environment.

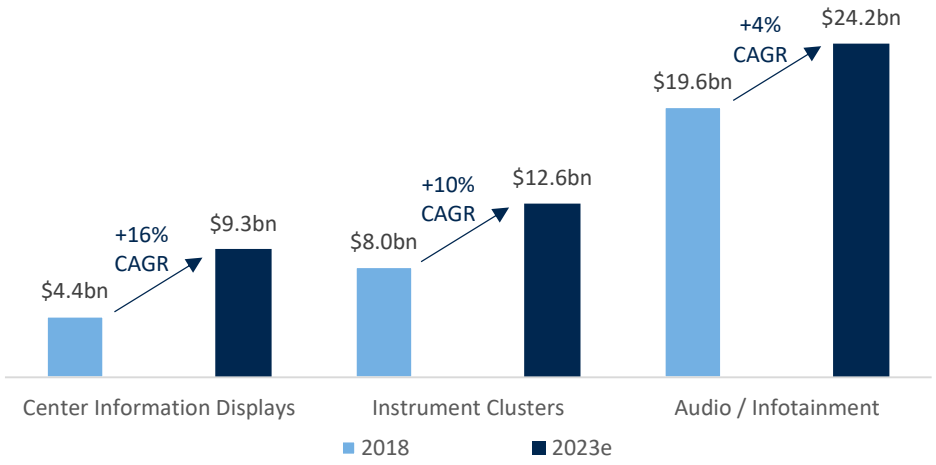
Introducing the personalized driving experience

While deep personalization is still somewhat nascent with respect to automobiles, consumers are increasingly looking for and expecting more customization and predictive behavior from their vehicles. The ability to personalize a vehicle's paint job and accessories is nothing new, but the concept of a car knowing a customer's tastes and gearing the driving experience accordingly is still somewhat aspirational. That said, more and more of today's cars are offering additional features, which allow just this, specifically when it comes to the cockpit experience.

Cockpit electronics have been a fast growing segment of the automotive business, which is expected to continue. According to Visteon (a leading manufacturer of cockpit electronics and connected car solutions), the cockpit electronics business is projected to grow more than 1.5x faster than underlying vehicle production over the next 5 years as the industry shifts to bigger, more complex digital displays that incorporate an increasing number of features designed to enhance the driving experience. While some of these features are along the lines of active safety and electrification, displays and instrument clusters within the cabin are being updated with better and more comprehensive technology to provide a safer and more engaging driving experience.

According to estimates from Visteon, the center information displays segment is expected to grow at a ~+16% CAGR over the next five years. This is driven by continued adoption of large displays that can be more incorporated with consumers' smart phones and offer additional integrated user interface technologies along with graphics management capabilities (navigation, rear view cameras, etc.). Similarly, instrument clusters are expected to grow at a ~+10% CAGR through 2023 as they benefit from the shift from analog to digital, which allows the clusters to show additional features and information. While much larger in market size than the two aforementioned segments, the audio and infotainment business is projected to grow at a ~+4% CAGR over the next 5 years. This growth is a result of more advanced audio capabilities, including streaming, voice recognition, and connectivity as well as the shift from audio to display audio, all of which enhance the uniqueness of a particular driver's experience.

Exhibit 33: Projected cockpit product industry CAGRs and market sizes



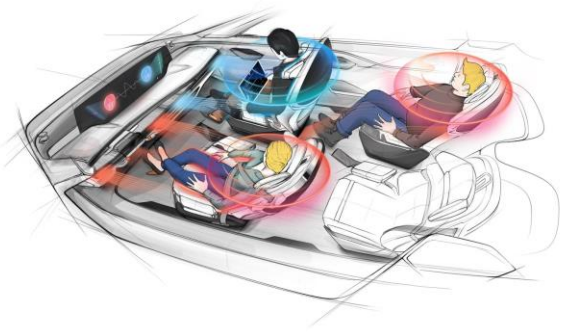
Source: Visteon, RBC Capital Markets

While the cockpit has already begun to incorporate an increasing number of these features, true personalization and predictive behavior in the cockpit is still years away. That said, several companies have begun to discuss what this enhanced cockpit could look like with a heavy emphasis on increased personalization and predictive behavior for an enhanced driving experience. Faurecia, a major French auto supplier, has outlined its "Cockpit of the Future" concept, which aims at supplying a more versatile, predictive, and connected environment to personalize the journey and allow vehicle occupants to maximize their driving experience. The concept hinges upon several attributes including active safety, comfort, smart human interfaces, and a more immersive customer experience.

Specific to unique customization, Faurecia highlights personalized climate comfort, which gives each occupant the ability to regulate his or her individual heating/cooling system without imposing their preferences on the other occupants. Similarly, Faurecia envisions a unique, immersive sound experience for each person in the car, which uses a combination of hardware

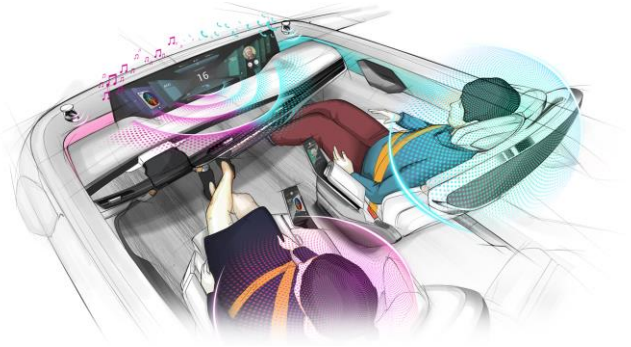
and software to individually manage each occupant's sound experience. Essentially, each person in the car would have their own "sound bubble" that would ensure they only hear what they are meant to hear such as individual phone conversations, personalized navigation, information, movie viewing, etc. without any interference from other occupants' sound bubbles. Additionally, individuals would have the opportunity to switch off their personalized sound space to be able to interact with their fellow passengers.

Exhibit 34: Personalized climate comfort



Source: Faurecia

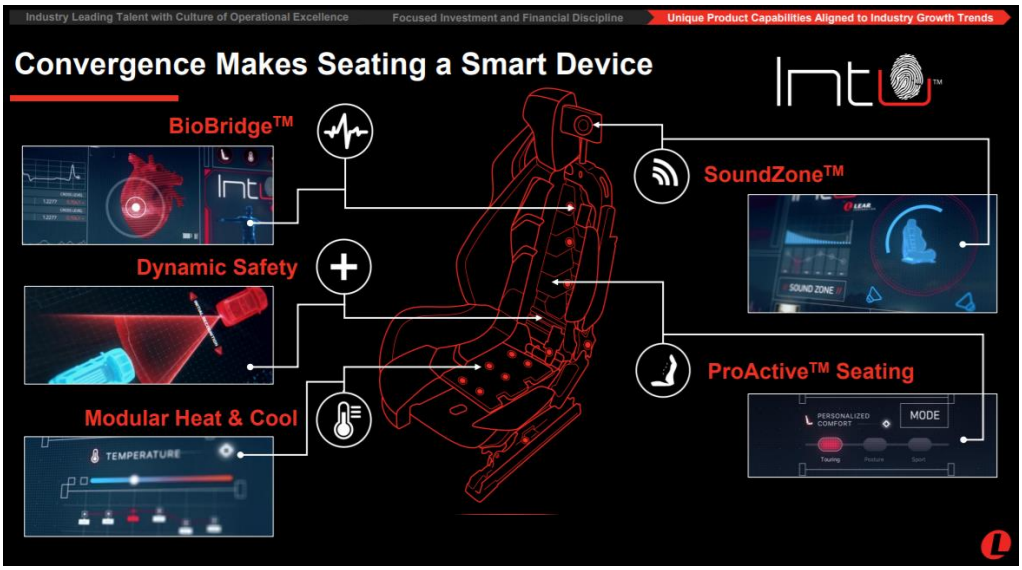
Exhibit 35: Immersive sound experience



Source: Faurecia

In somewhat of the same vein, leading seat manufacturer, Lear, sees the convergence of their e-systems and seating segments resulting in seats becoming smart devices. This concept incorporates modules that can be personalized to each occupant's preferences and allow for not only a more comfortable, but also a safer riding experience. These modules include BioBridge that monitors a driver's heart rate and understands if he or she is drowsy, Modular Heat & Cool Systems that adjust the temperature to meet each occupant's personal preferences, and SoundZone that pairs with each occupant's mobile smartphone and allows them to listen to his or her own music or take his or her own phone call.

Exhibit 36: Seating as a smart device



Source: Lear

Another view of what a more integrated and personalized cockpit could look like comes from China-based Byton, which believes its personalization and user experience will be a key differentiator of its soon-to-be produced pure EV. The company expects production of its first

vehicle, which will have L3 autonomous capabilities, to begin in late 2019 with deliveries in China projected to start in 2020, and deliveries in North America and Western Europe to begin in 2H20 and 2021, respectively. While Byton's vehicle incorporates several advanced technologies, it is highlighted by its 4-ft wide central display, which enables a more personalized experience. The display supports 5 types of user interaction including facial recognition, gesture recognition, driver tablet mounted on steering wheel, voice recognition, and traditional buttons (for functions where buttons are more convenient).

Exhibit 37: Byton cockpit

Source: Byton

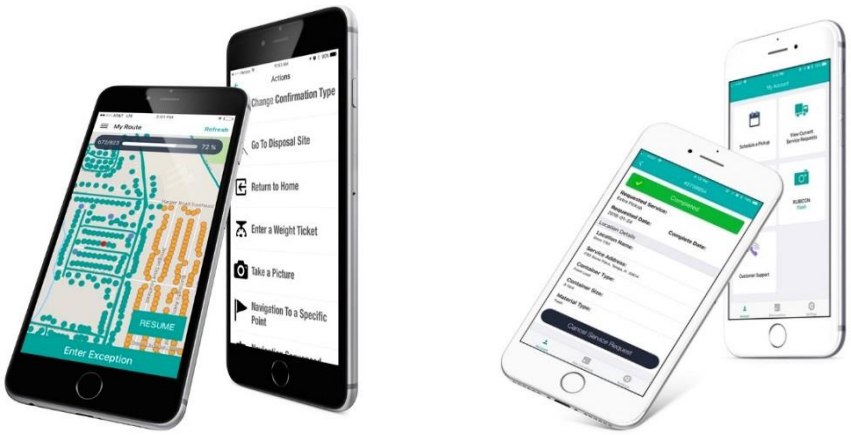
Further, Byton's long-term vision for the company is that of a shared mobility provider, which not only increases the utilization of its vehicles, but also drives enhanced personalization. The company sees customers as Byton members (vs. individual car owners) who will move around their home cities and cities to/from which they are traveling via a fleet of autonomous Byton vehicles, each of which would have the ability to be highly customized to each individual rider. Underpinning this vision is the idea that a consumer can move from Byton vehicle to Byton vehicle, with each fleet vehicle automatically recognizing the specific user and loading his/her unique preferences upon entry.

While still far away from commercial implementation, the cockpit of a vehicle is clearly undergoing a significant transformation. It is being re-defined to incorporate additional features that focus on enhancing the unique experience of each individual driver/passenger. As the amount of time/effort a driver must expend while operating a motor vehicle is reduced (via more advanced autonomous capabilities) and additional features are added to enhance passengers' in-vehicle experiences, the cockpit of a vehicle should begin to prioritize comfort, wellness, and entertainment, all of which would lead to increased personalization and predictive attributes.

More in the trashcan than meets the eye

Companies in the waste sector are developing ways to adapt to and offer bespoke customer services allowing for last minute changes, softening up on fixed collection frequencies, and removing order cut-off time. One example of such a development is the arrival of on-demand pick-up, enabling companies to quickly and efficiently respond to customer requests. Another example involves the "Uberization" of waste, whereby firms (using a specifically designed software platform) contract with local haulers and schedule on-demand pick-ups of waste without having to operate a fleet of trucks of their own. While the initial disruption began with tech companies such as Rubicon Global and Recycle Track Systems (RTS), more players are springing up and forcing the waste majors (ie. Waste Management and Republic Services) to take steps to implement this type of service. As we look forward several years and assess the potential for broader industry disruption, we would not be surprised to see on-demand pick-up apps emerge as a more prominent competitor to residential and commercial collection services.

Exhibit 38: A closer look at Rubicon Global's on-demand waste collection apps



Source: Rubicon Global

The smart-can can lead to smarter customers

In-truck tablets, cameras, sensors, and integrated cloud-based software are beginning to move beyond baseline GPS tracking to include the positioning of solid waste collection bins, road networks, population density, schedules, and truck capacities. Newer technologies are able to, through the use of sensors and cameras, assess the contents of a waste load in the back of a truck and determine how full the container is. We see this technology helping to provide information for clients in terms of what they are throwing out and the amount and frequency of it. While this technology may be a few years away from making it into the fleets of the waste majors, we think it could have the potential to increase landfill diversion and lower contamination levels in the waste stream as clients are provided bespoke waste information.

When coatings get personal

When we think of the ideas no one has yet to think of, we mostly think beyond fixing an immediate problem, such as climate change, digitizing a supply chain and leveraging AI. We believe the next step in the evolutionary cycle will be customer customization. Henry Ford said, "You can have any color you want, so long as it's black". Through any product lifestyle, as it evolves, consumers like to put the human touch on it and make the product feel like their own. Further, we believe in technology integrated into old economy products such as paints. Imagine, having the ability to change the color of your car with the tap of a button, or having your car change colors based on your mood detected by your wearable tech. On a more practical level, imagine a smart paint that included sensors woven into the paint that would alert a homeowner if there was flooding inside the house or there was a leak in the wall.

Exhibit 39: On-box packaging has become more ubiquitous

A 2019 Advertising Campaign by Chevrolet

Source: Wards Auto

The medium is the message: We believe that the corrugated packaging industry is in the early stages of a sea change from viewing packaging through a purely utilitarian lens to increasingly viewing it as a means for driving brand messaging and customer engagement. According to VC-backed packaging supplier Lumi, *"in today's world, the package you ship in is your storefront. It's the first physical interaction customers will have with your brand."* With the continued popularity of unboxing videos, retail brands have a meaningful opportunity to drive brand and customer loyalty in a world where brick-and-mortar is less and less important.

Exhibit 40: Corrugated packaging can be used to drive brand messaging

Source: Lumi

Personalization: As box converters gain expertise in bespoke manufacturing practices, we expect the industry will evolve to offer more personalized experiences for consumers. Below, we outline some potential applications of personalized containerboard:

- **Fast-moving consumer goods:** We expect that large retailers such as Amazon and Walmart could begin printing advertisements and offers targeted directly at the customer based on their online browsing and purchasing behavior.
- **Luxury retail:** For higher value and luxury items, we expect that retailers could delight consumers by offering additional customization such as imprinted names, invitations to exclusive events, and printed QR codes with special offers that can be redeemed within the company's mobile application.

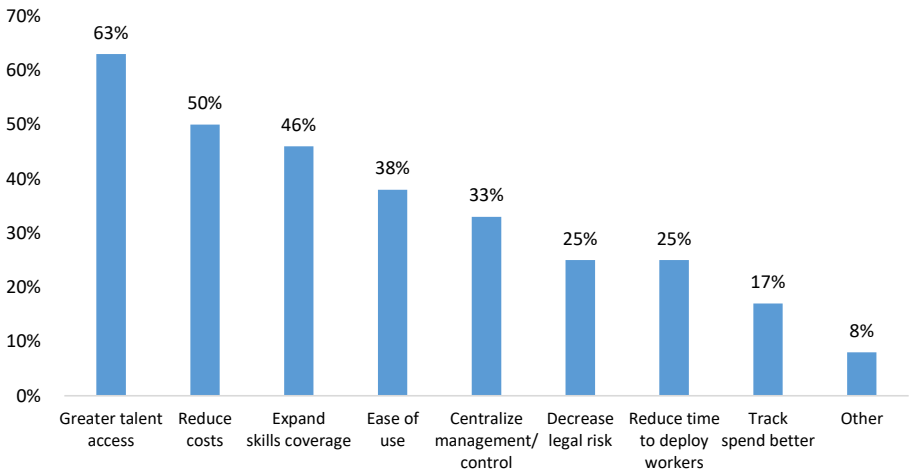
Beyond 2025 – Digitized packaging: BillerudKorsnäs, a Swedish packaging company, announced in July 2019 that the company had produced a paper battery on a paper machine. This technology would allow for the use of ordinary paper fibers in the manufacturing of batteries. BillerudKorsnäs management believes that the pilot production confirms that the company will be able to produce the material effectively at scale. Digitized packaging would enable packaging to utilize technologies such as augmented reality. For example, the box could detect when its contents are nearly emptied and re-order to keep inventory stable.

The personalized hunt for talent

With a widening skills gap in the U.S. amid low unemployment and rapidly evolving technology, talent scarcity is increasingly concerning for corporations, thus creating an opening for next generation solutions as the age of one-size-fits-all approach to job posting is waning.

In a 2016 survey conducted by Staffing Industry Analysts (SIA), the number one and three reasons companies turn to online staffing platforms are greater talent access and expanded skills coverage, respectively. To that end, we expect companies will increasingly demand tools backed by artificial intelligence and machine learning applications to more efficiently find talent that meets specific criteria. As we discuss in more detail in the Artificial Intelligence Evolution section, newer startups, big tech companies and staffing companies are working to solve this problem and offer more sophisticated micro-targeted solutions to their clients.

Exhibit 41: Primary reasons companies use online staffing platforms



Source: Staffing Industry Analysts (Workforce Solutions Buyers Survey North America, 2016)

Buying a house from the comfort of your living room

Moving has always been a hassle, especially if it is out-of-state. Multiple trips to see a few houses each trip or jamming as many home tours as you can into a few days, either way the process can be overwhelming. Not to mention buying a home is likely the largest purchase of a consumer's life and expediting the process into a mere few days is a recipe for disaster. However, it doesn't have to be that way. With advances in AR/VR technologies, instead of multiple flights across the country or weekends spent driving to different houses, we can imagine a world where you are able to simply put on a headset and tour any house for sale in the country. As a buyer, no more lining up appointments with a realtor or waiting for keys. As a homeowner, no more keeping the house in a state of perpetual perfection. This technology has the potential to change both the home buying and the home selling experience for the better.

Unfortunately, there is almost never the perfect house and there is always something to change in any house. However, we can extend this same VR/AR technology to the home building industry. Gone are the days of production builders mass-producing "cookie cutter" homes. Each home is now built specifically to your needs, wishes and design tastes. Instead of taping paint swatches to your wall or holding a small flooring sample to your cabinets, you can now walk virtually through your soon-to-be home, changing the paint, flooring, and cabinets at the push of a button. This can all be done to scale, in real-time. Instantly you could tell if that wallpaper will be overpowering or if your cabinets have the right contrast with your countertops.

Visualizing Paint through Your Phone

It is no surprise that we are becoming more dependent on our phones, using apps to communicate with friends, read news, bank, connect with customers and make the shopping experience seamless. The coatings industry is no exception. Sherwin-Williams has developed a mobile/web-based app that uses augmented reality to visualize any color on your walls. This is a good example of the transformation to e-commerce from brick-and-mortar and a trend that will likely only continue into the future. This new platform can better serve customers through the value chain while building brand loyalty and makes the shopping experience fun. This implication of the tool is two-fold. First, it creates an interactive consumer experience and a more confident paint selection. Second, it allows coatings companies to offer

complementary products, higher margin products and/or offer promotions (e.g. customer who bought xyz paint also bought this brush). The tool also builds in a level of stickiness with customers, as the application will now have a record of purchase, ultimately making it seamless to reorder the same exact paint for touch-up jobs. Even more so, the data SHW is collecting can be used in real-time to assess the success of a paint color and build a more profitable organization with less waste. In this new retail world, the customer is increasingly getting smarter and we believe the companies that can build product that match the experience the customer expects will thrive.

Printing buildings has never been this easy

We see a potential proliferation of 3D printing having implication for the E&C space, particularly in the buildings vertical. 3D printing involves joining materials under computer control to create three-dimensional objects. The process begins with raw materials and a digital design of a component, and then an object is created (i.e. "printed") from the bottom up, leaving minimal waste. There are numerous benefits and potential applications for this technology as it speeds up the design-build-test cycle, allows for significant customization, reduces supply chain lead times, and lowers waste. In the future, we see increasing usage of AI to help with the design process, including design for assembly and disassembly, which generally requires complex iterations in order to achieve design optimization.

Exhibit 42: Example of 3D printing technology in the construction industry

Source: Innomotive

Theme III: In Cloud We Trust

The adoption and utilization of cloud technology is rapidly changing the landscape of corporate IT as well as corporate competition across industries. The democratization and affordability of cloud computing and storage is fueling the rate at which companies can start, scale, and succeed. As basic cloud services become more affordable with price cuts, we think premium services such as intelligence, machine learning, and advanced compute will continue to be introduced at affordable rates, giving high-power tools and capabilities to businesses of all sizes. Access to, and utilization of, these tools increases the ability of small and new entrants to industries to keep giants on their toes.

What you need to know

Cloud technology and the Internet of Things (IoT) is redefining the way global industrials companies do business. The tech is becoming increasingly essential for agility; companies that want to run powerful software, but lack the hardware and compute requirements can run those programs from the cloud, essentially renting infrastructure and compute needs. This gives companies the leverage and ability to scale quickly and affordably. The most commoditized portions of cloud (storage and compute) will become less expensive with scale and time; premium services (intelligence, processing, advanced compute) will continue to be introduced and utilized. Importantly, a cloud-centric world moves faster. Digital transformation within companies will be necessary to keep up in the environment of rapid change, churn, and disruption.

Key In Cloud We Trust developments include:

As vehicles are equipped with more and more technological features and autonomous driving-related hardware (sensors, cameras, etc.), automobiles will generate an increasingly large amount of data. While some computing will continue to be done in the vehicle, much will shift to the cloud. Vehicles are perhaps the poster child for the Internet of Things, and new business models focused on utilizing and monetizing that data can be enabled.

Increased collaboration powered by cloud technology is possible among Engineering & Construction (E&C) companies enabling Building Information Modeling, which is the process of designing a building collaboratively using one coherent systemof computer models rather than separate sets of drawings.

Sensors out on the farm? IoT provides big potential by connecting technological advances, such as automated tractors, sensors, drones, and precision sprayers working in unison, while storing substantial amounts of data.

Smart water networks represent the biggest growth opportunity within the global water sector.

Cloud technology makes "smart home" connectivity possible, whereby electric devices are tied to a central network that allows for automation and control over the home.

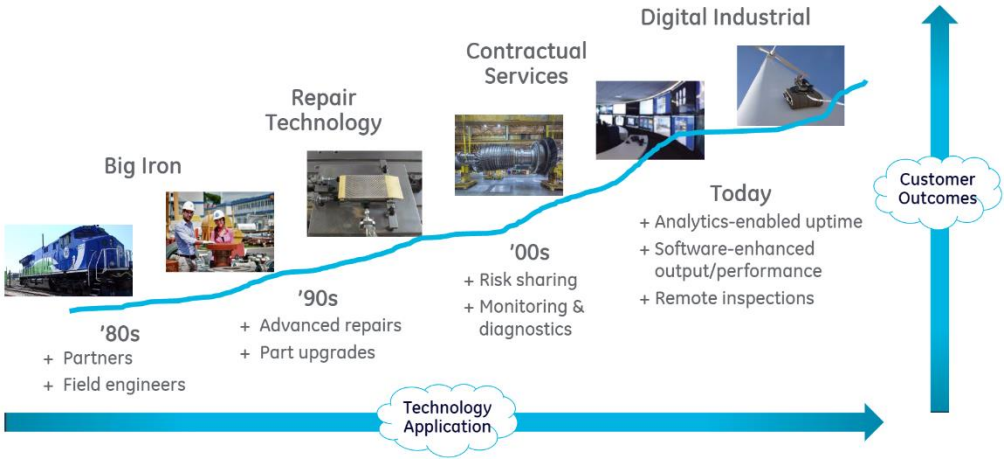
Incremental cost efficiencies and improved asset utilization for customers will come from the "Internet of Things" and software as a service (SaaS) capabilities as the value proposition of physical engineering is reaches its upper limit.

Companies Highlighted: GE, Cisco, AT&T, Oracle, Intel, Honeywell, Roper, Xylem, Evoqua, Fortive, Danaher, AquaVenture, Whirlpool, Amazon, Google, GM, Volkswagen, Aptiv, Ford, Deere, AGCO

Connecting the Industrial Internet

Software and digital capabilities are supplanting physical assets in importance among the industrials. Market leaders within the industrials have long depended on their "moats" to maintain their dominant positions within their respective domains—such as their expansive installed bases of equipment built over decades of operations and their long-term multi-year service contracts. But we believe that the next frontier of growth and innovation within the industrials will not be tethered to physical assets, but rather, will be comprised of digital services that can control and monitor equipment and aggregate data. Specifically, we would argue that the value proposition of physical engineering is reaching its upper limit; from here, the bulk of incremental cost efficiencies and improved asset utilization for customers will come from the "Internet of Things" and software as a service (SaaS) capabilities. Importantly, digital solutions are exponentially more flexible and responsive to continuous improvement than physical assets (i.e. the amount of time it takes to revise a line of code is a mere blip compared to the time it takes to revamp a product's engineering or a factory's assembly line). As the rate of change accelerates within the industrials, the speed in which companies are able to embrace and leverage the disruptive power of software will keep them at the forefront of this sea-change from the "physical" to the "digital".

Exhibit 43: Evolution of Services at GE



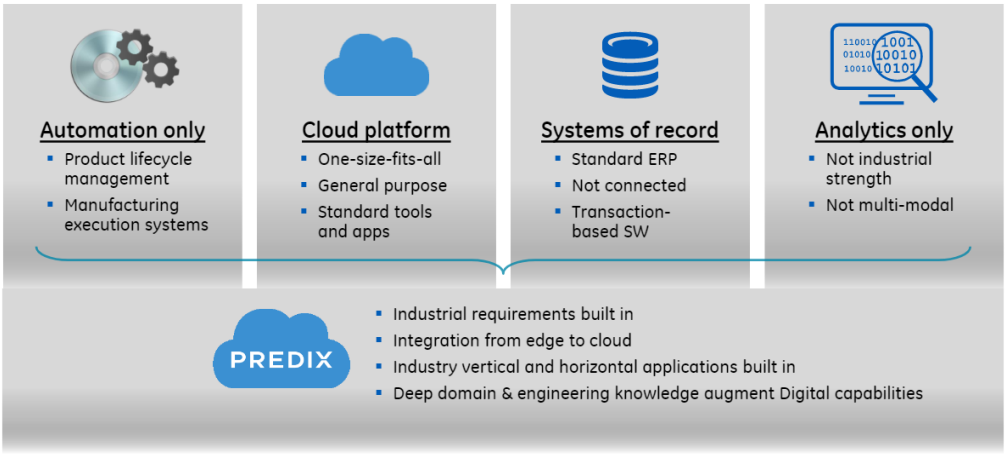
Source: GE Company reports

M&A will likely be the most effective and agile growth strategy for the industrials within the software space. Despite a parade of early movers in this space, no single player has yet emerged as the dominant leader within the new frontier of the "Industrial Internet". For a while, GE looked to be the most likely leader, given its forays into Predix as early as 2014 and initial successes in building a flexible and open-sourced platform for the Industrial Internet. But this software suite, while certainly differentiated, has not been sufficiently ground-breaking or paradigm-shifting to overcome the company's systemic market challenges across oil & gas, locomotive, and power gen. Given this arguably underwhelming result from GE's multi-year organic investments, we believe that most of the industrials will instead opt to grow out their SaaS and Digital capabilities through M&A deals, rather than capitalized spending. We have seen acquisitions emerge as the crux of the digital strategy for many Multi-Industry companies, such as Roper, Honeywell, Xylem, and Emerson. The reason is because disruptive innovations within the Internet of Things have mostly originated from start-ups and Silicon Valley, and are not guaranteed to be unlocked through internal investments. As such, rather than pour endless capital at aimless R&D, it has become more effective to simply acquire the latest software technologies, patents, and talents. The upshot is that we would expect a flood of acquisitions of SaaS businesses over the next decade.

Industrial companies successfully operating in software today

- **GE Digital:** Of all the companies in the industrials, GE has embraced software and the Silicon Valley ethos the most through its GE Digital business, which was recently carved out into its own independent subsidiary. The company had an early-mover advantage in the gold rush to develop software for the Industrial Internet, having poached a number of external hires from tech companies to lead its software development efforts. The result is that GE has already added over 400 partners to its GE Digital platform, including Cisco, IBM, AT&T, Oracle, and Intel, and over 35,000 developers of Predix apps. The forays that GE Digital has made in developing the Industrial Internet should position it well for the next data-driven frontier. We expect GE to eventually spin this business off.

Exhibit 44: GE Predix Value Proposition



Source: GE Company reports

- **Honeywell:** Honeywell has also been on the forefront of emphasizing its software and connected offerings. In fact, one of CEO Darius Adamczyk's first major messages was that he would transform the company to a "Software-Industrial". In 2018, software accounted for $1.5 billion in sales, or 4% of total sales, and is growing at a robust double-digit Y/Y CAGR. Some of the key end markets for software at Honeywell include aircraft, building infrastructure, and plant cyber security. Sentience remains the cornerstone of Honeywell's software offering and provides a common open architecture platform that helps speed up the development of offerings.
- **Roper:** Roper's approach to software investing has been different than other companies within the industrials sector. While it was one of the first industrial companies to recognize the attractive growth opportunities within SaaS, its unique "holding company" philosophy meant that it kept businesses relatively independent and standalone within its portfolio. As such, Roper is not beholden to the typical necessity of finding assets that are complementary or synergistic with its existing businesses, resulting in an eclectic portfolio that encompasses construction ERP providers, legal and professional services software, laboratory information systems, RFID tolling tags and systems, and food supply chain management solutions, among others. SaaS businesses now account for over +60% of its earnings mix, and are likely to continue expanding over the next decade.
- **Xylem:** Within the global water sector, Xylem's FlexNet platform is arguably the broadest and most multi-functional SaaS platform for the emerging field of smart water networks, encompassing remote diagnostics and controls and predictive maintenance for a broad array of water equipment and services. The company expects SaaS-based revenues to grow at a 10% CAGR through 2020, as more water utilities adopt data analytics to better

manage their water infrastructure assets. We believe that smart water networks will remain a critical pillar in the ongoing trends towards "smart cities".

- **Evoqua:** More than most companies in the industrials sector, Evoqua's strategy for introducing software capabilities thoughtfully leverages its existing core competencies to create an offering that cannot be easily replicated by competitors. Its new Water One platform has become a key pillar of its service value proposition by providing customers with real-time data and remote diagnostics. What makes this offering unique however is the fact that Water One is backed by Evoqua's years of water treatment/servicing expertise, mobile fleet of RO units, and expansive service branch network (4x as many branches in the US as its closest competitor). As such, the software solution here is primarily an augmentation of Evoqua's existing resources, and not the showcase solution itself, in contrast to offerings like GE's Predix. We believe that Evoqua's Water One will be critical for transitioning customers towards adopting a business model of "water-as-a-service" over the next decade, wherein customers learn to outsource the production and treatment of their water and pay on a "per gallon" basis.
- **Fortive:** Given the trend that good equipment needs good software to meet its customer's needs, Fortive has been working to include SaaS offerings with its equipment offerings. Currently, 10% of sales are from SaaS. In Fortive's Fluke business, the market-leading brand offering professional test and measurement tools, the company has rolled out the Accelix platform. This allows Fluke's equipment and sensors to be digitally managed, monitored, and controlled. While the business has seen some acceleration and pilot programs are going well, the company has yet to see rapid adoption.

Smart Water is the Wave of the Future

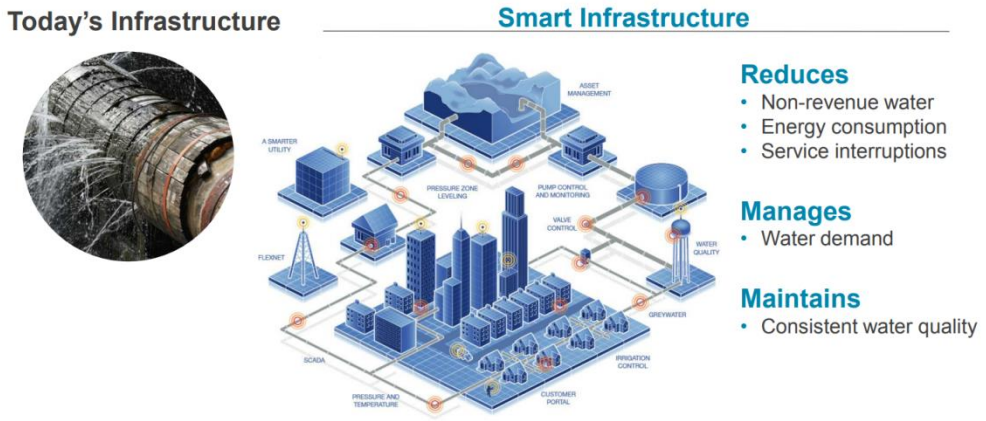
Among the biggest benefits for customers from the adoption of smart water is risk mitigation, followed by cost savings.

Smart water networks represent the biggest growth opportunity within the global water sector. Around the world, water infrastructure is being strained by aging equipment and long-deferred maintenance, reflecting an urgent need for investment and improved asset management. The solution to this dilemma is known as smart water networks, which utilizes connected devices, the Internet of Things, and information technology to help municipalities improve their monitoring and diagnostics capacities, optimize investment dollars, ensure proper stewardship of watersheds and infrastructure, and serve their communities more effectively. At water equipment trade shows globally, so many companies are showcasing new connected products and services that it can be hard to differentiate the imitators from the true pioneers. Regardless, by 2025 and beyond, we expect this proliferation of smart equipment and data analysis to intensify, transforming the way that water utilities make decisions around resource management and capital investments. Key examples of smart water systems and providers include:

The Claros platform can streamline the process of publishing Discharge Monitoring Reports for official EPA records, automating a tedious manual task.

- **Danaher's Hach** business is leveraging its market leadership in water analytics/test to scale its new Claros water intelligence system, which marries instrument management, data management, and process management to allow for real-time controls, predictive diagnostics, and automation of manual tasks.
- **Xylem** has stated that nearly 50% of its revenues are now either smart or smart-enabled, thanks to its landmark acquisition of Sensus and the build-out of its disruptive Advanced Infrastructure Analytics platform.
- **Evoqua** is applying its water treatment expertise, unmatched service network, mobile RO fleet, and installed base of 25,000 customers to launch its new Water One platform, which significantly expands its capabilities in "Outsourced Water".
- **AquaVenture** is capable of remote monitoring its network of desalination systems.

Exhibit 45: Xylem Smart Infrastructure



Source: Xylem Company reports

Pricing paradigms for new smart water offerings are still being refined and done on a case-by-case basis. Given that the adoption of smart water systems by municipal and industrial customers is still in its early innings, it is no surprise that many water companies are still refining their pricing and commercialization strategies for these brand new offerings. There is not a one-size-fits-all strategy, and it can often be dependent on whether the customer prefers to spend opex or capex dollars. Both Xylem and Danaher have emphasized that they are still in the early innings of their transitions from product sales towards subscription, pay-as-you-go, and SaaS models, which drive attractive recurring revenues. That all said, typically the biggest barrier to entry and gating factor is the willingness of the utility customer to adopt new technologies, rather than the pricing itself.

Traditional tech companies lack the domain expertise to pose a significant competitive threat to water-focused companies. Large traditional technology and software companies like SAP, AT&T, IBM, and Oracle have attempted to elbow into the water sector by applying their broader enterprise software and data analytics offerings. However, penetration of the water sector can often be a challenge for companies that lack crucially important water industry domain expertise and are not familiar with the fragmentation of the sector or its regulatory landscape. Despite these barriers to entry, traditional technology and software companies will likely remain a major constituency within the global water sector.

Specialized buoys in the water off of JFK and LGA airports are equipped with water test equipment to detect jet fuel spills and de-icing chemicals.

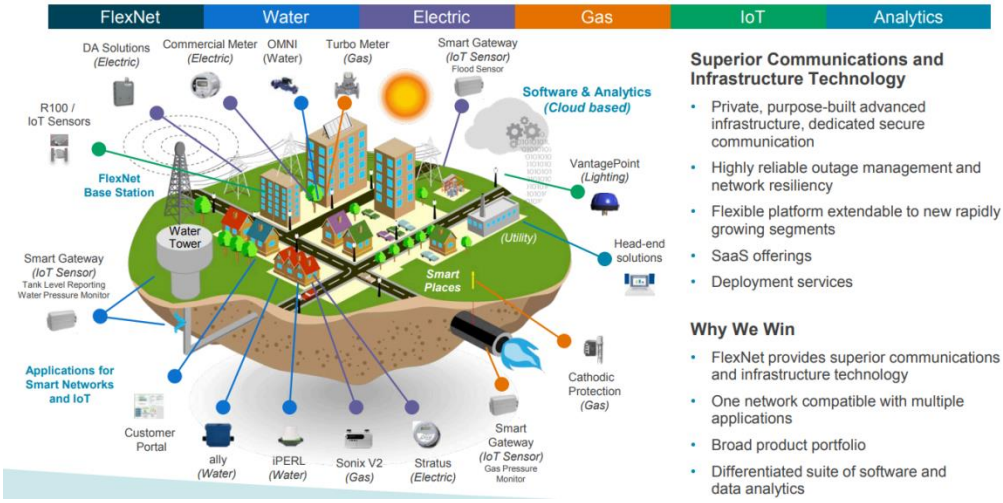
Case study: NYC water utility using AI and smart networks to drive cost efficiencies. New York City's Department of Environmental Protection (DEP) oversees the largest municipal water and sewer utility in the US, which supplies roughly a billion gallons of water per day. The utility generates all of its revenues from the issuance of water bills to property owners, which is used to fund operations and maintenance and debt payment. Since 2000, the water board of NYC has raised water rates by 3x to fund the city's network of aging water infrastructure (including equipment installed as far back as 1910). For now, the DEP is focused on deploying AI and smart networks to drive cost efficiencies and reduce opex. Over the past year, the utility has installed automatic testing instruments, SCADA control systems, and robotic buoys across its reservoirs that can perform real-time analyses. The utility performs roughly 60,000 water analyses/tests per year. That said, much of the water contamination that occurs comes from the lead in the pipes of old city buildings. Another source of investment is the mitigation of combined sewer overflows, per new regulatory standards, given that NYC's sewage and storm water are both collected in the same system.

Case studies: Xylem's smart water technologies. No water company has advanced smart water networks and solutions more capably or aggressively than Xylem, in our view. Its new

Advanced Infrastructure Analytics (AIA) platform is an incubator of smart water solutions and technologies, and is currently comprised of its acquisitions of EmNet, Pure Technologies, Visenti, HYPACK, and Valor Water Analytics. Broadly speaking, we would characterize AIA as essentially an "incubator" of new water technologies within the Xylem portfolio, with a mandate to develop and pilot innovative software and data analytics solutions that combat the biggest threats that water utilities operators face, such as aging infrastructure, storm water management, non-revenue water, combined sewer overflow, and more. Management expects organic revenue growth in this new platform to outpace the rest of its portfolio by at least 2x over the long-term, implying a double-digit pace of growth. Some case studies of Xylem's successful deployment of smart water solutions for cities include:

- A private utility in **Singapore** was experiencing leaks and breaks across roughly nine miles of new steel trunk main and was unable to determine the cause. By implementing Xylem's high sample rate pressure sensors and advanced analytics, the areas of high pressure causing these breaks were discovered and mitigated, eliminating the issue and generating roughly $15 million in savings for the utility.
- **Clayton County**, Georgia's utility was looking to identify and quantify apparent losses across its meter network. By applying Xylem's Hidden Revenue Locator, the County achieved a four-fold improvement in locating meter registration gaps and identified over $1 million in annual lost revenue. On a per-meter basis, the solution discovered revenue losses of $6 for the average residential meter and $67 per non-residential meter.
- When the city of **South Bend**, Indiana was facing a billion-dollar consent decree for combined sewer overflows, it commissioned Xylem's BLU-X intelligent sewer solution, which utilizes a combination of sensors and AI to provide real-time decision support and system controls. As a result, the city reduced its combined sewer overflow volumes by over 70% and E. coli concentrations in the St. Joseph River by 50%. The capital required to comply with the consent decree was also reduced by over $500 million.
- **Baltimore County**, Maryland worked with Xylem to implement a comprehensive force main assessment program that leverages the company's SmartBall, PipeDiver, and PureRobotics inspection technologies. These assessments determined that 3.5% of pipes showed signs of deterioration, though only 0.5% required repairs. Thanks to Xylem's technologies, the County was able to safely and cost-effectively manage its system while avoiding unnecessary and onerous replacements.
- The city of **Grand Rapids**, Michigan was looking to certify the performance of its sanitary sewer system, which includes one of the largest distributed sensor networks out of any storm water and wastewater utility in the country. By utilizing Xylem's BLU-X analytics and visualization tools, the City found that many of these projects were not actually necessary, reducing capital infrastructure program needs from over $1 billion to less than $50 million.

Exhibit 46: Xylem's Sensus Solutions for Smart Cities



Source: Xylem Company reports

House on a Cloud, but it's not Quite Heaven Yet

Cloud technology makes "smart home" connectivity possible, whereby electric devices are tied to a central network that allows for automation and control over the home. Today, smart home connectivity looks like lights dimming for a romantic evening when you say "Alexa, living room lights at 50%" or turning on the air conditioning through the Nest app while you're still a few blocks away from home in the scorching summer heat. Other examples include setting security alarms, turning a sound system on or off, flipping between TV channels, and shutting the blinds – all without physically having to do any of those things.

Today's smart home technology is cool, definitely. Show it off to your friends and family who don't have cloud-enabled connectivity in their homes, and they'll be impressed. It makes life a little bit easier too, and theoretically, it has the potential to save money and be environmentally friendly if the connectivity encourages more responsible energy usage. That said the current state of smart home technology is a bit one-note: namely, turning various things on or off. We envision the connected home of the future as far more integrated.

Take Whirlpool, the world's leading global manufacturer and marketer of major home appliances, for example. Whirlpool has a suite of smart kitchen appliances, which includes microwaves, stoves, and ovens. Each of these can be controlled hands free with voice control through a voice assistant, or accessed remotely through an app. How convenient! You no longer need to wash flour off your hands before preheating the oven when you're in the middle of kneading dough – you can just say it! …but you'll have to wash your hands in a few minutes anyway to actually open the oven because, well, the technology is not there yet. The remote access app touts the ability to pre-heat from afar, and the ability to keep food warm while you're away by delivering a low amount heat to the oven (users can judge the safety of turning ovens on without anyone home for themselves).

In 2017, Whirlpool acquired Yummly, a recipe search engine that makes personalized recommendations and can arrange grocery delivery. Today, after selecting a recipe on Yummly, the app can order the necessary ingredients, or if you opt out of that step, it can pre-heat your Whirlpool oven accordingly to help you get started. The app also provides step-by-step cooking instructions, through easy to follow videos. Great, but not exactly cutting edge. We expect that Whirlpool has plans to take this a step further. For example, connecting to the

sensors in your smart fridge, so it would know what ingredients you already had. It could offer substitutions based on your existing inventory and then fill in the gaps with grocery delivery. It could time the delivery around your schedule, which it obtained through coordination with your voice assistant. If the delivery beat you home due to unforeseen traffic, it could unlock your door for the delivery person with the help of your smart security system. Finally, by the time you walk in the kitchen, the oven or stove top preheated and ready to go when you are.

We imagine that by 2025 there will be more seamless integration of all smart home devices. That said, it is really the tech industry leading this revolution. Companies in our space (like Whirlpool) are stakeholders, to be sure, but generally speaking lack the scale and capabilities to invest billions of dollars like Amazon or Google to create and own the smart technology. Take the example above with Yummly and the hypothetical future version – who is the more practical owner of this type of integrated technology, Whirlpool, or Amazon (which owns Whole Foods, has an existing scaled logistics business, already is a dominant force across connected home appliance, and whose investments dwarf our entire sector's R&D budget)? To us, this suggests that as the home becomes "smarter", our companies (homebuilders and building products companies alike) will participate and offer connected features using compatible architecture, and occasionally can create first-mover advantages vs. competition, but this will become more of a requirement and difficult to offer true differentiation since partnerships with Amazon's Alexa or Google Home will be abundant.

Driving mobility through cloud integration

As vehicles are equipped with more and more technological features along with the cameras and sensors associated with autonomous driving (a trend that will likely only accelerate moving forward), vehicles will generate an increasingly large amount of data. On the other hand, these additional features also increase the amount of signals and commands a vehicle receives, which all need to be processed. Both of these factors necessitate that future automobiles are equipped with highly efficient data processing capabilities. However, given weight and size constraints, not all of this computing can be done in the vehicle (i.e. edge computing). As the technological complexity of vehicles increases with the growth of autonomous and additional infotainment features, more and more of the computing will shift to the cloud. A balance between edge computing and cloud computing is likely to occur with time-sensitive actionable computing being done on the edge while low frequency/high latency computing is done in the cloud.

Today, given autonomous is still quite nascent, the cloud is predominantly used for over the air (OTA) updates. While laptops and other technological devices have used OTA updates for some time, auto OTA updates have emerged more recently. It wasn't until 2012 when Tesla pioneered automotive OTA updates by introducing features through the cloud such as the ability to save driver profile settings by name along with a coast function that allowed the vehicle to roll forward without the driver having his or her foot on the accelerator. Tesla has since expanded the capabilities of its OTA updates and now pushes out software updates to manage vehicle range, battery charging/thermal controls and FSD capabilities, among others. More recently, we have seen other OEMs introduce and expand their OTA update capabilities as well.

In May, GM announced its new digital vehicle platform, which utilizes a new family of on-board controllers (OBCs) and software, and has ~5x more processing power (4.5tb/hr) than the existing platform. GM believes this platform puts them in a leading position in electronic architecture, especially in cybersecurity. Controllers with enhanced over-the-air (OTA) update capabilities will allow for more functions in the vehicle to be updated (from ADAS to infotainment to powertrain calibration). The platform is expected to be first on the 2020 Cadillac CT5 and on all global vehicles by 2023.

GM is not the only automaker looking to enhance its cloud capabilities. VW announced a partnership in late 2015 with Microsoft to use its Azure platform to develop the Volkswagen Automotive Cloud. VW's vision is to create a seamless experience for drivers from vehicle entrance to exit allowing occupants to continue to perform tasks (music, calls, etc.) in a smooth and uninterrupted experience. More recently (February 2019), the two entities announced plans to extend their partnership to the US and China markets (was previously mainly focused on the European markets). VW's ID model family will be the first generation to use the VW Automotive Cloud, which is expected to launch in Europe in 2020. China ID production is also projected to begin in 2020, while US production will not start until 2022.

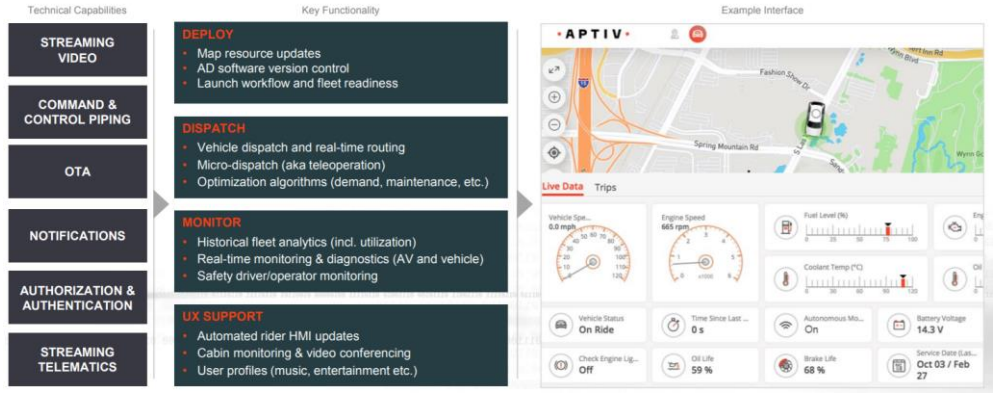
Exhibit 47: Volkswagen Automotive Cloud

Source: Volkswagen

Cloud enabled connectivity is not limited to just an owner and their personal vehicle. As ride hailing has grown, there are significant opportunities to increase the communication between a ride-hailing fleet and a central command center. Further, while autonomous is still in very early stages, the cloud would be crucial in allowing third party mobility providers to eventually manage their fleet of autonomous vehicles.

Leading active safety and electrical solutions auto supplier, Aptiv, has been conducting autonomous vehicle tests in conjunction with mobility provider, Lyft, in Las Vegas since 2018. The company has since expanded its partnership to four additional cities around the world and continues to expect driver-out-of-the car AV testing to occur by the end of 2020. While Aptiv does not see itself as an AV fleet operator, the company is committed to supplying the automated driving system for autonomous mobility on demand (AMoD). A key component of this service revolves around data monetization along with fleet monitoring, which will be powered by the Aptiv Mobility Cloud. This will allow mobility providers to actively manage and monitor their fleet, and even intervene (if/when necessary), all from a central command center. Further, the mobility provider will be able to send specific commands and potentially tele-operate any of its vehicles depending on the situation.

Exhibit 48: Aptiv mobility cloud



Source: Aptiv

While the cloud will undoubtedly enable more connectivity between car owners and their vehicles as well as between independent vehicles (V2V), the true value of the cloud is enabling connectivity between vehicles and everything (V2X) leading to the idea of a more connected city. This has significant ramifications in terms of how cities are designed to account for more modern forms of mobility and transportation, which is currently still somewhat rudimentary. As more and more methods of transportation (buses, ride hailing, scooters, etc.) add increasing levels of complexity to cities, it will be paramount that these methods can communicate and interact.

With the increased modes and variations of shared mobility comes a wealth of data, which can allow alternative mobility companies to improve their deployment and repositioning. Overall, the largest benefit of increased data from connected cities is likely to be improved travel times along with smarter decisions during the day relative to which form of transportation is optimal for a given task and at a given time of day. The cloud is what will enable not only the vehicles to communicate with each other and other electronic devices, but also for the data to be interpreted, and then used to create more integrated transportation networks and ultimately more integrated cities.

Connected cities are increasingly becoming a topic of discussion amongst auto companies and an opportunity that OEMs are beginning to position themselves to take advantage of. Following a 2017 initial investment in Autonomic (open cloud-based platform developer), Ford acquired the remaining portion of Autonomic in January 2018, making the company a fully owned subsidiary of Ford Smart Mobility. With the acquisition, Ford gained Autonomic's Transportation Mobility Cloud (TMC), which will not only ingest and enrich vehicle data in real time, but also give software developers access to the processed data to allow the creation of value-add applications for drivers, fleet owners and OEMs, thus providing the tools for increased integration. Ford recently signed a multi-year global agreement with Amazon Web Services (AWS) for AWS to power TMC, which will become the standard connected car solution for all Ford vehicles.

Trucks and trains elevated to the clouds

We believe that analytics may increase the effectiveness of the salesforce in the transportation industry. Both the railroad and the trucking industry have seen a renewed focus on profitably and a move away from a narrow focus on volume growth in recent years. This is clearly evident as the railroads implement Precision Scheduling Railroading, which often involves the de-

marketing of certain volumes and a re-alignment of the operations and marketing functions to focus on profitable sales. Going forward we believe analytics will further align the operations and sales teams at transportation companies through a better understanding of what revenues drive the most persistent long-term earnings, thereby better incentivizing the sales force.

Our view is that the cloud may significantly improve route scheduling at transportation companies. A major benefit that we believe could come from advances in artificial intelligence is improved route scheduling. We do expect there to be some benefits to the railroads in this regard but we expect the improvements to be more incremental as the railroads have their own in-house scheduling programs and more simple routes that are confined by track infrastructure. However, we think the opportunity for trucking, LTL, and last mile businesses is much larger. First, the routes that trucking companies travel are much more complex. For example, a courier might drop off 20 packages in a day and must decide what route to take to drop the packages off to minimize distance, avoid traffic, and maximize profitability. Taking in all of these factors to maximize profit is beyond the scope of human cognition and we expect artificial intelligence to vastly improve this process. Second, we expect cloud solutions to make this technology available to smaller players who do not currently have the budgets available for large investments in IT infrastructure. However, we still believe that a certain amount of scale will be required to reap the full benefits of AI and that the industry is likely to see some consolidation going forward. We expect this technology to increase capacity in the transportation industry.

Even your garbage collection will be on the cloud

With the prevalence of cloud-based systems and technologies penetrating into the IT infrastructures of various industries, we continue to see a focus on utilizing data and insights from the perspective of the customer to drive analytics and value-added offerings. Platforms such as Republic Services' Capture pricing tool, are examples of technologies being used by waste companies to not only drive down customer defection rates, but to also show (and justify to) customers the precise services that they are paying for. We would expect these tools to become more widespread in the coming years, as both customers and companies increase the rate at which they employ data-driven approaches in their day-to-day operations.

Data is the new oil, and the waste industry has barrels of it. Every collection and disposal interaction offers many data points and client profiling opportunities that can be leveraged to improve the customer experience and move up the value chain. At the 2019 Waste Expo, we heard ways that both private and public companies are looking to capture and monetize client data along the route. The waste industry drives almost every municipal road in North America on a weekly basis. This offers intriguing opportunities to build new cloud based data sets and solutions that can be routinely updated. New ideas include everything from tracking and reducing the collection-to-disposal distance of each pick-up, to road condition monitoring and real-time vehicle dispatching.

Landfill ownership and control of the waste stream at disposal (back-end) generally provides for the best margin profile. With low variable costs, landfill disposal is attractive economically. Collection (front-end) is more capital and cost intensive (labor, vehicles, etc.) and comes with a lower margin and FCF profile. However, the vertically integrated waste majors will likely use collection as feedstock into their landfills (internalization), which makes collection valuable. We note that as more data is gathered at the collection point and throughout the collection process, we see this information shifting the value proposition more towards the front-end of the waste stream.

Building into the clouds together

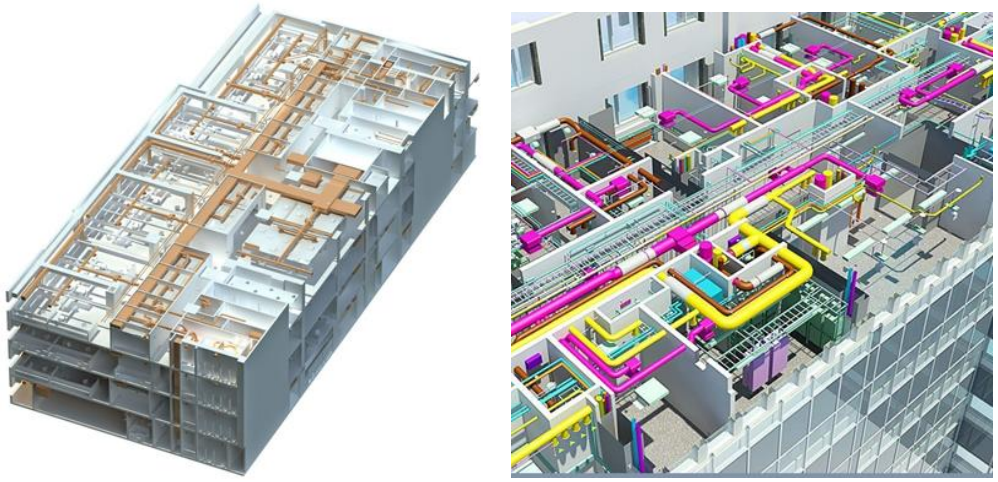
Digitalization drives increased collaboration

An area where we see a significant long-term opportunity for E&C firms to drive efficiencies is through greater utilization of digitalization and the use of cloud based networks. In light of the high-degree of collaborative work that goes into cross-functional, project-based work, we see E&C firms as well positioned to benefit from an acceleration of cloud-based solutions that allow for data storage, document sharing, and many other opportunities. Examples of technologies that are already in use and have the potential to be leveraged further through cloud & AI-based offerings include:

Building Information Modelling (BIM)

BIM describes the process of designing a building collaboratively using one coherent system of computer models rather than separate sets of drawings. BIM is relevant to the civil engineering sector as a whole (and not just Buildings as suggested by its name). At its technical core, BIM is a software that enables 3D modelling and information management. Advantages offered by BIM include cost & time savings, lower project risk, greater accuracy in estimation, and avoidance of error, alterations and rework due to information loss. We see this becoming increasingly used in larger applications – including augmented and virtual reality site plans.

Exhibit 49: 3D Modeling and BIM software offers collaborative sharing of designs

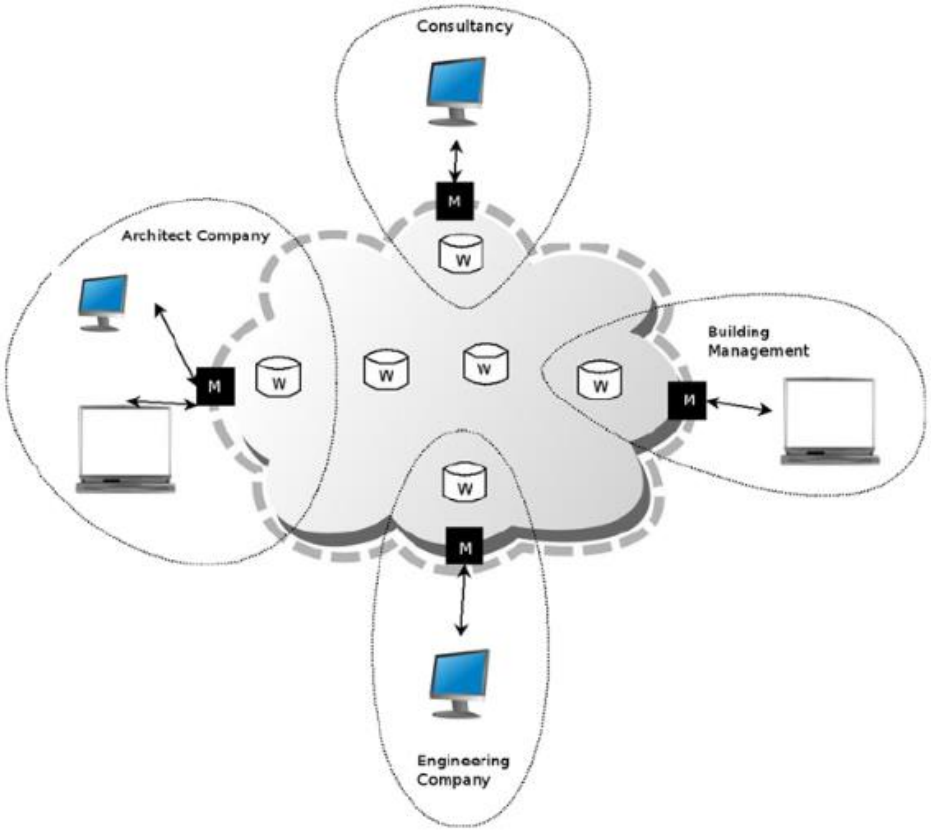


Source: Engineering News-Record

Enhanced information sharing through Project Management software

Data sharing amongst project stakeholders (engineers, architects, builders/foremen, etc.) through digitization can support multi-user collaboration and therefore facilities modification or revisions to existing blueprints while mitigating the risk of costly and time-consuming delays associated with such changes. Project Management (PM) software in engineering and construction helps in effectively managing communication, decision-making, budget management, job scheduling, and cost control. Construction projects involve numerous moving parts wherein multiple companies and contractors are required to work together. This can be effectively managed with the help of PM software as it enables a systematic approach towards project completion on time and on budget. Furthermore, PM software helps to plan, control and coordinate the project from beginning to end.

Exhibit 50: Cloud-based solutions can facilitate data sharing amongst key project participants



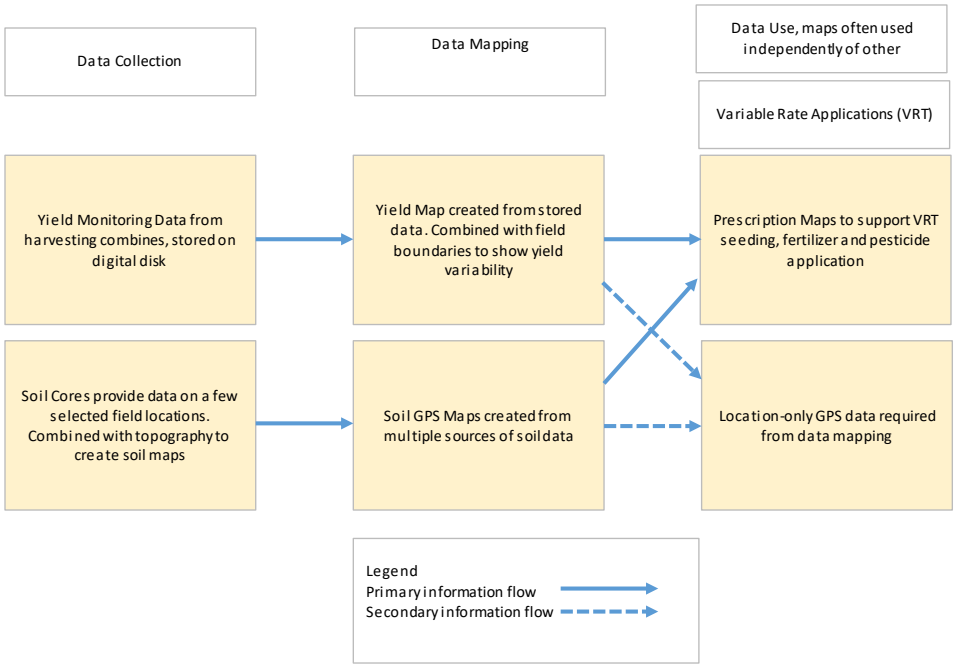
Source: The Journal of Cloud Computing: Advances, Systems, and Application 2013, RBC Capital Markets

Sensors out on the farm?

Sensors and smart farming/connected machines are contributing to the growing proliferation of farm/crop-related data, which is increasingly being used for situational awareness and management decisions, including real-time assistance during suddenly changed operating conditions. IoT provides big potential by connecting technological advances, such as automated tractors, sensors, drones, and precision sprayers working in unison to create a more efficient farm while utilizing machine learning to adjust treatment of crops due to changing weather patterns, infestations, etc. Barcelona, for example, implemented an IoT-enabled, smart irrigation system using underground probes to monitor soil moisture. Remote monitoring devices upload data to the cloud and automatically open electronic valves resulting in a 25% lower water bill and reduced water usage.

We believe adoption rates skew toward larger/better capitalized operators at this point as implementation carries some up-front equipment costs, particularly for large systems. Therefore, adoption in developing markets could take longer than expected to evolve. Separately, limited broadband coverage in some rural areas could be an issue, although recent US legislative proposals are designed to improve that. Lastly, we believe there is some generational bias, as older farmers are more reluctant to adopt and share data, although we believe younger farmers are more likely to embrace the change and benefits available. To that end, the growth of big data and remote accessibility would put a premium on cybersecurity in order to preserve the confidentiality of data.

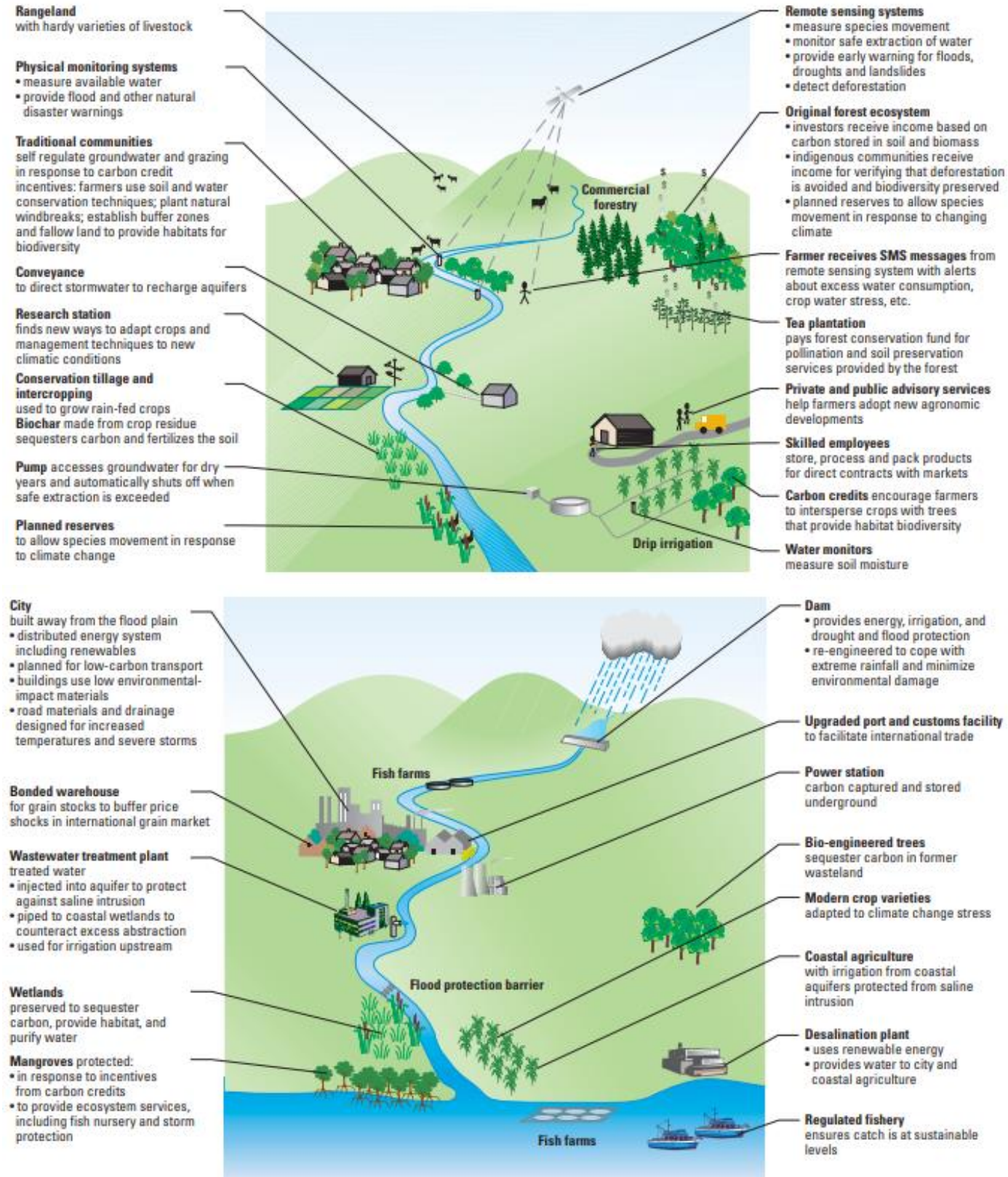
Exhibit 51: Key Precision Ag Technologies and Information Flows



Source: USDA, National Geographic

The World Bank Group, in a 2010 report, described an ideal farming community utilizing climate-smart technology to create a sustainable landscape. Technology included physical monitoring systems, conservation tillage and intercropping, planned reserves and remote sensing systems.

Exhibit 52: Ideal Climate-Smart Agricultural Landscape



Source: World Bank Group WDR team

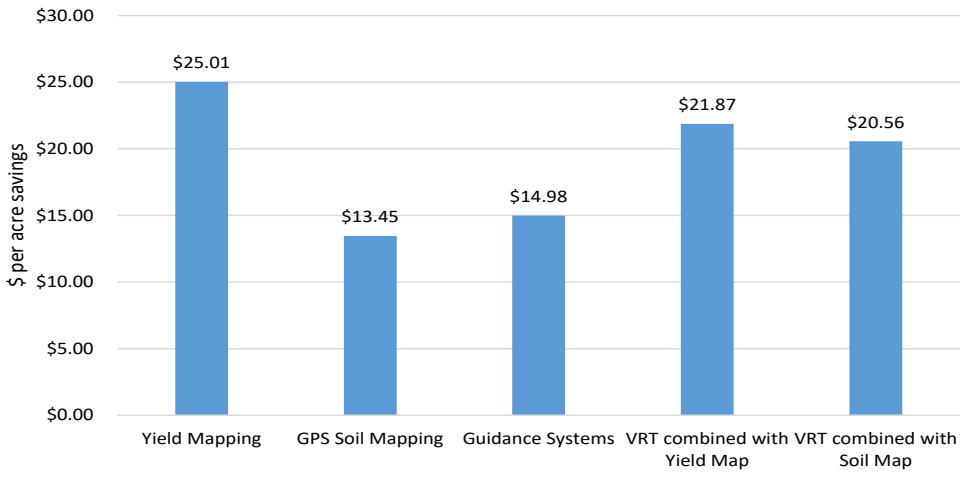
The convergence of traditional farming equipment, technology, and big data is a prime example of change forces underway in our coverage. In an ongoing push to improve crop yield/productivity and manage costs, farmers have been heavy adopters of technology; smart/precision farming is a bigger part of the landscape while newer categories include the likes of genetically engineered crops.

Smart farming and the integration of greater technology into the farming process are helping get more from existing resources (arable land, water) in order to help feed a growing global population with changing diets. Adoption has evolved over a relatively short period of time from the advent of GPS/navigation in the late 1990s to predictive analytics (to increase equipment productivity and consistency) and machine coordination (more efficient/effective farming). Today, much of the focus is on the collection and transfer of data from machines to enable better farm/field management decisions (e.g., variable fertilizer/chemical applications, seed spacing, measuring potentially different crop/soil conditions) as the evolution toward machine learning continues.

We expect the trend toward embracing tech/data -- including AI/machine learning -- to accelerate as farmers seek ways to maximize productivity/yield, improve crop quality, and reduce costs/improve machine uptime. We see the benefits of this shift as having potential to help mitigate subdued farmer economics and drive some equipment demand. Some studies showed near 5% corn yield improvements from using variable rate seeding vs. fixed rate whereas sensor based nitrogen application increased yields by 2bu/acre while reducing nitrogen usage (University of Missouri Extension). Further, we expect growth in remote diagnostics to help drive higher margin parts sales. We expect developed markets to lead, but also see opportunity in emerging areas as costs decline.

We expect the evolution to favor larger incumbent equipment manufacturers, given the significant value ascribed to their established dealer networks/farmer relationships (i.e., farmers' reluctance to share their data with unknown entities), resources to fund or acquire new technology/data initiatives, and importance of the equipment/existing fleets as the medium of change. Equipment OEMs Deere and AGCO have used acquisitions to supplement internal development as the pace of change accelerates, with recent examples including Deere's acquisition of Blue River Tech and AGCO's purchase of Precision Planting.

Exhibit 53: Average production cost savings ($/acre) from technology adoption



Source: USDA, Deere

Theme IV: Collective Action

The power to act collectively has never been greater given technology and the viral speed with which social sharing can occur. As a result, long-held beliefs in traditional institutions, social norms, and commerce are being challenged. Trust in one's peers vs. legacy institutions is quickly taking hold, as is the idea of decentralized organizations vs. centralized ones. As a result, we believe the pace of disruptive change will accelerate, but also believe increased collaboration between historical adversaries could increase, as incumbents seek to partner for survival via self-cannibalization and disruptors seek change at scale. In either case by 2025, we believe, as history has taught us, collective action will have transformed industries, evolved business models, and challenged the status quo.

What you need to know

The power of collective action is undeniable, as history has illustrated through the years, ranging from the Civil Rights Movement, to the uprisings of the Arab Spring (Tunisia and Egypt among others), and most recently with the #MarchforOurLives Movement. And with an estimated 65% of people globally expected to have internet by 2020, the ability to act collectively has never been easier. We urge investors to imagine a world with 100% global Internet penetration (helped by further lowered costs of devices/access and emerging mesh technologies). Where will society be five years thereafter? What inefficiencies will be brought to light? And while rapidly improving connectivity is a central driver of our Collective Action theme, it is the general deterioration in trust levels between consumers/citizens and traditional institutions/organizations that is motivating this phenomenon.

Key Collective Action developments include:

Environmental regulation and climate change continues to reshape and reform a diverse range of industries and sub-sectors within the industrials space. As discussed below, we highlight the importance of renewable energy, smart farming, EV adoption, and paper straws as companies cope with the impacts of an ever-changing global climate. As we look towards the future, we find ourselves asking what new innovative technologies, equipment, or services may be required to further combat these ongoing changes.

Environmental, Social and Governance (ESG) criteria are becoming of increasing importance when making asset allocation decisions and winners and losers, from this process are likely to be amongst the most apparent for industrials. From the environmental standpoint, industrial companies that will benefit from the ESG trend will be those that contribute to lower pollution and that support the shift to renewable energy sources. Companies that benefit from the social and governance aspects will be those that demonstrate most effectively that they have taken steps to minimise the probability of operational, financial or reputational damage.

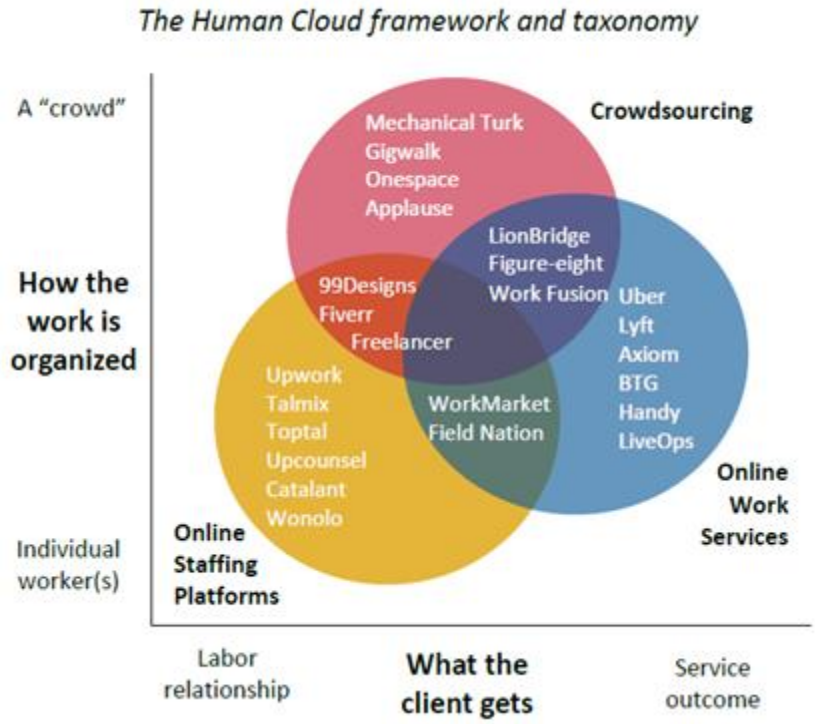
Social connectivity and the "gig" economy have paved the way for a more digitally-enabled labor market while both changing the way people find work and employers source labor. Given profound advancements in workplace connectivity and technology, it has become easier for employees to work remotely and employers to fill temporary/project-based labor needs. Going forward we see online labor marketplaces, the proliferation of social media, and increasing global connectedness as posing some disintermediation threat to traditional staffing companies while also providing further opportunity for talent sourcing within existing social networks.

Companies Highlighted: Uber, BMW, Volkswagen, Renault, PSA, Daimler, Ford, GM, Aptiv, Intel, Google (Waymo), Lyft, Volvo, Baidu, Amazon, Atlas Copco, ABB, Siemens, Schneider Electric, OC Oerlikon, Bodycote, Spirax Sarco, Rotork, IMI, Hexagon, Coats Group, Flowserve, Emerson, SPX FLOW, Fortive, Dover, GE, Cascades, Nestle, PepsiCo, Danone, Carlsberg, AGCO Corporation, Deere & Company, SNC Lavalin, Union Pacific, CSX Corporation, Norfolk Southern, Canadian National Railway, Canadian Pacific

Connecting the global labor force

Connectivity has paved the way for a more digitally-enabled labor market (i.e., gig economy, human cloud), changing the way people find work/employers source labor, manner in which work is completed (e.g. remote/off-site), and the nature of worker/employer relationships. In this section, we examine some of the more important developments in connectivity and the labor market, as well as demographic shifts and the potential impact on the labor dynamic.

Exhibit 54: The human cloud framework



Source: Staffing Industry Analysts (The Global Gig Economy, November 2018)

Social connectivity and digitalization modernizes the labor economy

The rise of digital platforms/online labor marketplaces has been one of the most important developments surrounding employment arrangements, providing companies the access and means to directly source and contract independent workers to fill temporary/project-based/permanent labor needs. The industry has experienced a rise in specialized and general pure play online staffing platforms, including Upwork, Toptal, and Upcounsel, to name a few.

The value proposition of pure-play online staffing to clients (employers) vs. incumbent models is noteworthy, including efficiencies (e.g. streamlined interviewing/screening/contracting), real cost savings (estimates from 35-80%), and access to high-quality talent. Further, as younger generations begin entering the workforce, they will expect mobile tools to be standard, with instant feedback, control, and flexibility at the touch of a button.

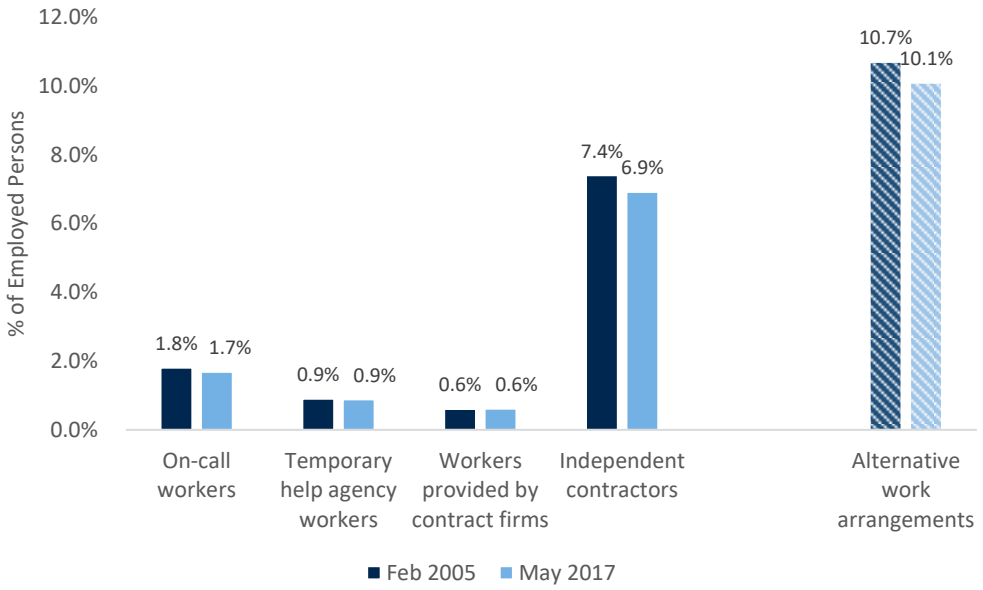
While these marketplaces pose some disintermediation threat to traditional staffing companies, the proliferation of social media and the power of sharing and global connectedness also provides significant opportunity from a talent sourcing perspective that pure play platforms and staffers can leverage. For example, Facebook, with over 2.4 billion monthly active users, has the highest active user base of any social network platform. We expect staffing companies to allocate greater recruiting efforts within social networks.

Is the gig economy gaining steam?

Much of the media coverage has focused on the millennial generation and their desire for more work flexibility to achieve a better work-life balance. Given the profound advancements in workplace connectivity and technology solutions, it has become easier to work remotely while maintaining (or improving) worker productivity.

Increased desire for workplace flexibility supports the notion that people may increasingly seek out alternative work arrangements (the "gig" economy). However, data from the BLS suggests that has not necessarily been the case, with the share of employed persons in alternative arrangements declining in 2017 vs. its 2005 survey to 10.1% from 10.7%. This is in direct contrast with an oft-cited 2016 NBER study, which suggested 94% of net employment growth from 2005 to 2015 occurred in alternative work arrangements, with its share at 15.8%. In a January 2019 report, the NBER report authors revisited their original research in attempt to reconcile the differences in their survey conclusions versus the BLS 2017 CWS data, **ultimately concluding that although it believes a modest upward trend in alternative work arrangements did occur, it was not as sharp as their original report suggested.**

Exhibit 55: Alternative work arrangements as percent of total employed in the US



Source: BLS, RBC Capital Markets

We believe there are several reasons that increased desire for flexibility has not necessarily led to more independent work:

1) The tight labor market and record economic expansion has made it easier for people to secure full time employment. Full time employment has several advantages to independent work from a worker perspective, including company-provided benefits (e.g. health insurance, retirement plans) and tax advantages. In addition to paying regular income taxes, independent contractors are responsible for paying self-employment taxes (Social Security and Medicare) unlike full time employees where the employer pays half.

2) Rising uncertainty in the global economy exacerbated by increasing geopolitical tensions may drive a preference for the stability of a full time job.

3) Employers are increasingly responding to demands for more flexible work arrangements and more attractive benefits, including relaxing remote work/work-from-home policies, expanding paid time off policies for new parents, and adding more unconventional perks like student loan assistance, free gym memberships, subsidized daycare, etc.

So perhaps the growth of truly independent workers (i.e. freelancers, independent contractors) is not as drastic as the media suggests, but the encouraging thing is that the percentage of the workforce characterized as temporary help agency workers was static period to period, and one of two categories that did not shrink from 2005 to 2017. Unlike true freelancers or independent contractors, temporary workers employed by a staffing agency are treated as regular employees, receiving a W-2 and not subject to self-employment tax. Further, the technology revolution has allowed corporations to use more contract and temporary labor in their drive for efficiency and cost savings, while the trend of outsourcing non-core capabilities supports demand for process-oriented services that many staffers offer.

Gen Z vs. Millennials

As providers of labor and broader workforce solutions, we believe staffing companies will increasingly focus on driving initiatives to better target the needs of younger emerging workers. Looking beyond the frequently discussed millennial generation, Generation Z will begin to enter the workforce in the coming years, and their behaviors and preferences will have a growing influence on workforce dynamics. The impending Gen Z demographic shift will likely change the way employers and staffing companies attract and retain young workers.

Various surveys and studies suggest that Gen Z places greater emphasis on an empowering work culture and corporate social responsibility than millennials and older generations, with employer loyalty less frequently tied to higher salaries/raises.

In addition, Gen Z is the first generation to grow up with advanced technology embedded in nearly all aspects of their lives, making them more technically proficient than millennials. On the flipside, Gen Z's social skills are less developed as digital communications (texts, messaging, social media) have dominated the bulk of their interactions.

Labor getting scarcer and margins getting narrower

Gig Economy

As the gig economy gives workers more autonomy, we would expect the labor shortages that are currently plaguing the homebuilders and building products space (in April 2019, there were 434,000 vacant construction jobs in the US) to only worsen. Simply put, most gig economy employment tends to be more desirable than manual labor. Why bear the elements and physical strain nailing together the wooden frame of a new home on a hot summer day when you could earn a living driving for Uber from the comfort of your air-conditioned vehicle? Most wouldn't, and we should note that this example (working construction for a homebuilder) isn't even one of the most strenuous jobs in the space. Take insulation installation for example, which involves close contact with fiberglass. Fiberglass insulation can irritate the skin, causing redness and itchiness. Contact with fiberglass can also lead to issues with seeing and breathing, or other more serious ailments. Installations are time consuming and often require working for extended periods in cramped spaces, like attics or crawlspaces. While this type of work is higher paying than other construction jobs, it remains undesirable. Our sense is that this will become an even bigger problem as the gig economy continues to offer more employment alternatives – especially those perceived to be less dangerous, difficult, or dirty than construction work.

The impact of the gig economy is coinciding with an aging workforce and questions (to say the least) about whether immigration policies will allow for sufficient supplemental labor.

As labor gets scarcer and continues to push costs higher, companies will need to adapt or productivity and profitability will be threatened. Our sense is that offsite construction and robotics (see Agility Imperative) will be key to combatting competition from the gig economy.

Transitioning from auto enemies to frenemies

The automotive industry is cyclical, highly capital intensive, and facing the need for accelerated investment to be able to transition towards a world of electric and autonomous vehicles. As such, we are seeing a number of companies (sometimes competitors) look to collaborate to spread the cost (and the risk).

Electrification: In aggregate, global automakers are poised to spend $300bn on electric vehicle technology over the next 5-10 years according to Reuters. This investment alone would equate to roughly 15% of the global auto industry's $2 trillion combined market value. Much of this spending is aimed at complying with government CO2 mandates – particularly in Europe and China. Only a little over a year ago, that total was $90bn, suggesting the current forecast might even be too low. As a result, given the large capital spend requirements and fragmented nature of the industry (lack of scale necessary at the individual company level), collaboration between the OEMs is critical for several European auto OEMs, in particular, to survive.

Exhibit 56: Potential fines at current CO2 levels could be catastrophic for European OEMs

	2018*	2021 Target*	Excess Penalty*	Annual Penalty (€M)	% 2018 EBIT
BMW	128	101	27	€ 2,878	45%
VW	123	96	27	€ 11,442	103%
Renault	112.5	93	20	€ 4,305	179%
PSA	114	94	20	€ 5,049	88%
Daimler	132	103	29	€ 3,044	33%
Fiat	120	91	29	€ 3,521	

Note: CO2 g/km
Source: RBC Capital Markets estimates, Company reports

Notably, Renault-Nissan-Mitsubishi have forged an alliance where shared R&D and platforms to produce EVs have given the OEM group a unique advantage over smaller European OEMs. The construction of Volkswagen's multi-brand empire has also helped the company achieve the scale to make the necessary EV investments. On its own, brands like Porsche and Audi would not be anywhere as profitable as they are without the shared R&D spend with VW Brand, especially on EVs.

Ford announced an agreement with VW to buy 600,000 MEB (packaged battery and associated components) as part of its EV push in Europe. We would not be surprised if more OEMs seeking penetration into the European EV market participate in similarly collaborative purchase agreements.

GM and Honda are collaborating on EVs with Honda purchasing battery modules from GM. Earlier this year, Ford invested $500mm in Rivian to develop an all-new BEV for their portfolio using Rivian's flexible skateboard architecture. Additionally, Ford will be able to gain knowledge about areas like batteries (Ford and Rivian use different cell technologies) and electrical architecture.

In China, BMW-Great Wall announced plans for a JV that would produce low-cost NEVs in China under the MINI and Great Wall brands. Geely and Daimler also have an agreement to build the next-gen of Smart cars as EVs in China via a JV.

Autonomous. Autonomous vehicles are a massive undertaking and require a lot of investment, engineering resources, and scale. As such, we have seen a number of alliances for autonomous

investments, which highlights that the capital needed to execute on autonomous efforts could be greater than appreciated.

For example, Honda announced they will partner with GM's Cruise including taking an equity stake in Cruise. Honda will work with GM and Cruise to fund and develop a purpose-built autonomous vehicle that can serve a wide variety of use cases (so not only passengers, but potentially delivery). They will also jointly explore global opportunities for commercial deployment of the Cruise network. We note that Honda's Asian footprint (Japan has been very focused on AVs) is mostly complementary to GM's. Cruise's most recent valuation was $19 billion.

In conjunction with their EV partnership with VW, Ford also announced that VW will invest in Argo AI. VW will contribute $2.6bn including $1bn in cash and its Autonomous Intelligent Driving (AID) unit as well as $500mm over 3 years to invest in Ford's Argo AI partner at a $7bn valuation. Strategically, we like the move to combine Argo with VW. This is because we believe AV is a difficult challenge that will require a lot of resources and capital. Further, AV talent and know-how is somewhat capacity constrained, and Argo now gets 200 employees from AID. Argo is responsible for the self-driving system, while F and VW have independent go-to-market plans.

BMW has one autonomous consortium with Aptiv, Intel/Mobileye, FCA, and Magna. But they are also cooperating with Daimler on Level 3 and Level 4 automation for on-highway applications. They expect the product to be market-ready by the middle of the next decade. They also plan to discuss the possibility of extending their collaboration to cover higher levels of automation, both on highways and in urban areas, and are open to other partners.

Waymo (Alphabet's self-driving unit) has arrangements with Fiat Chrysler, Jaguar Land Rover and the Renault-Nissan Alliance. Further, they've formed partnerships with companies including Lyft, Avis and car retailer AutoNation.

Uber Advanced Technologies Group (ATG) announced they are working with Volvo and unveiled a new generation of self-driving Volvo XC90 SUVs that are designed and built to be fully driverless – a critical milepost for the company as it inches toward deployment of a robotaxi service.

Baidu's Apollo self-driving initiative has a consortium of over 100 partners.

Amazon has invested in Aurora, an autonomous driving startup co-founded by Chris Urmson, former CTO of Alphabet self-driving cars. They followed that up by leading a funding round for electric pickup/SUV start-up Rivian. We note that Amazon is clearly investing in logistics and, in our view, these latest signs of dipping into auto could mean they are looking at more than last-mile transport options. Aurora has also partnered with traditional automakers FCA and Hyundai, with FCA entering into a partnership to develop a self-driving CV fleet and to explore installing Aurora's systems on Ram/Fiat Professional Brand vehicles, while Hyundai invested in Aurora (taking a minority stake).

Chinese telecom company, Huawei, is collaborating with Audi, Toyota and several Chinese automakers to produce AVs as early as 2021. Huawei and Audi had previously signed an MOU in July 2018 to jointly develop intelligent connected vehicles.

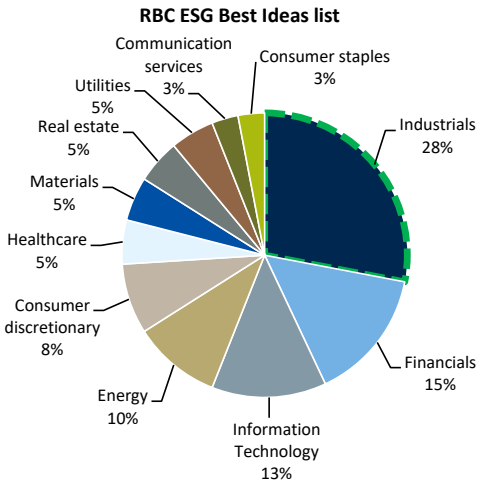
Mobility Projects. Another key area where global auto partnerships make sense is related to the various mobility projects (ride-hailing, parking, car-sharing, and autonomous). Given that many of these endeavours will likely not meaningfully contribute to company financials in the near-term but require substantial up front R&D investments, shared investing among OEMs and suppliers has and continues to be an important strategy. Key examples of this includes

Daimler's and BMW's mobility collaboration (REACH NOW, CHARGE NOW, FREE NOW, PARK NOW, SHARE NOW) as well as Toyota's and DiDi's collaboration to focus on vehicle-related services for ride hailing drivers. Further, in terms of autonomous, which is potentially decades away in terms of mass market adoption, Ford's and VW's joint investment in Argo, Honda's investment in GM Cruise, or Waymo's and FCA's ongoing partnership, could be crucial for these technologies to reach critical adoption in the future.

ESG investing is here to stay, but who will the winners be?

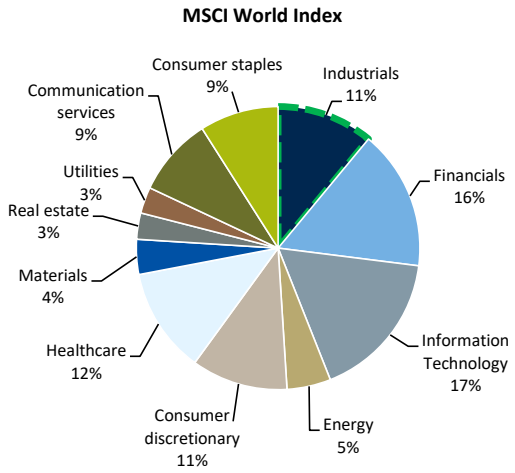
Among the most significant developments in the investment industry in recent years is the growing prominence of sustainable investing. Investors are increasingly assessing Environmental, Social and Governance (ESG) criteria when making asset allocation decisions, in addition to traditional metrics associated with financial performance. This will likely create winners and losers, and there are few sectors where this would be more apparent than industrials. Given the breadth of the industrial landscape and its links to virtually every major source of energy consumption (power generation, transportation, chemicals, etc.) it comes as little surprise that at 28% industrial companies account for the largest share of RBC's recently released ESG Best Ideas list, compared to the sector's 11% share of the MSCI World Index.

Exhibit 57: Breakdown of RBC's ESG Best Ideas list



Source: RBC Capital Markets estimates

Exhibit 58: MSCI World Index – lower share for industrials



Source: MSCI

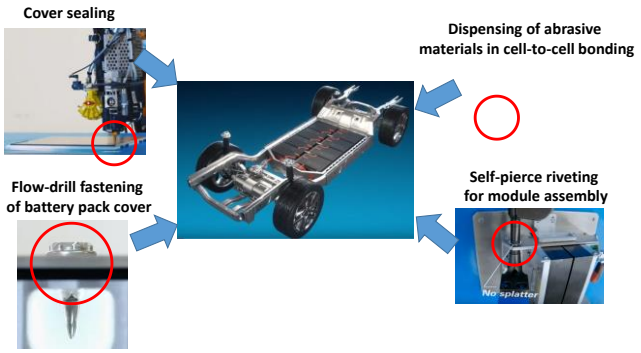
From the environmental standpoint, we believe industrial companies that could benefit from the ESG trend would be those that contribute to lower pollution and support the shift to renewable energy sources. We think companies that benefit from the social and governance aspects will be those that demonstrate most effectively that they have taken steps to minimise the probability of operational, financial or reputational damage. We look at some of the more noteworthy ways in which companies in our European Industrials coverage achieve these aims.

Environmental

While renewable energy is growing in importance, for the foreseeable future fossil fuels will remain the bedrock of human energy consumption. This increases the need for industrial products and processes that make the use of fossil fuels more efficient. Examples of how this can be accomplished include:

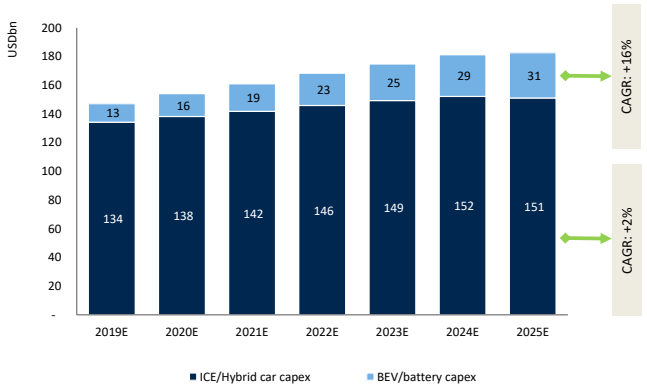
New production facilities for EVs: Given the unique demands of manufacturing BEVs, auto OEMs will need to build new assembly lines. To explore the impact of this, we built an automotive capex model and our work here suggests that between 2019 and 2025 BEV-related capex will have to grow at c16% p.a., and will constitute the main source of overall investment growth. We therefore view the shift to BEV technology as a significant opportunity for capital goods companies supplying automotive assembly-line equipment. In particular, we highlight Atlas Copco as a likely beneficiary of this trend.

Exhibit 59: Atlas Copco is well placed to provide equipment for BEV assembly lines



Source: Atlas Copco

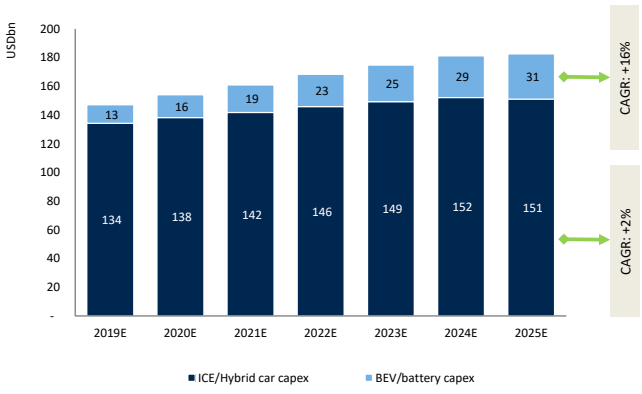
Exhibit 60: Auto capex growth driven by 16% pa growth in BEV investments



Source: Auto company reports, RBC Capital Markets estimates

Electricity infrastructure for EVs: For EVs to become viable on a large scale, it will require a significant improvement in electrical infrastructure. ABB (charging points), Siemens and Schneider (grid upgrades, charging points) stand out here.

Exhibit 61: ABB charging infrastructure



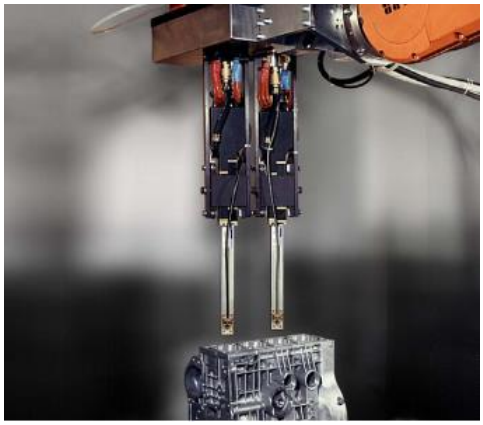
Source: ABB

Exhibit 62: Schneider Electric charging points

Source: Schneider Electric

Lighter components: Reducing the weight of components is essential to reduce the emissions of cars, commercial vehicles and aeroplanes, among others. Relevant technologies here are surface coating and heat treatment (Oerlikon, Bodycote), which makes components more resilient, obviating the need for heavier parts.

Exhibit 63: Oerlikon coating process for engine cylinder bores



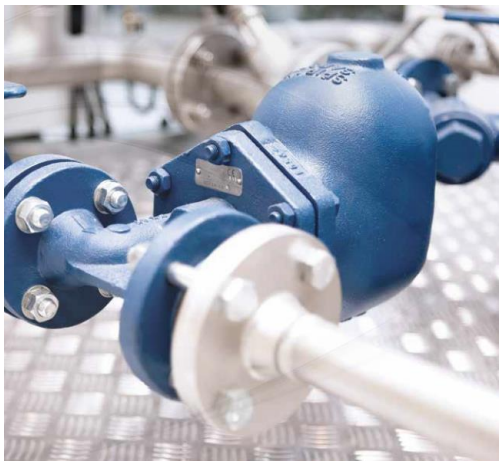
Source: OC Oerlikon

Exhibit 64: Bodycote heat treatment

Source: Bodycote

Maximising efficiency in process industries: Spirax Sarco (steam solutions), Rotork (actuators), IMI (valves) and Siemens all provide solutions for enabling the efficient movement of fluids.

Exhibit 65: Spirax Sarco steam trap



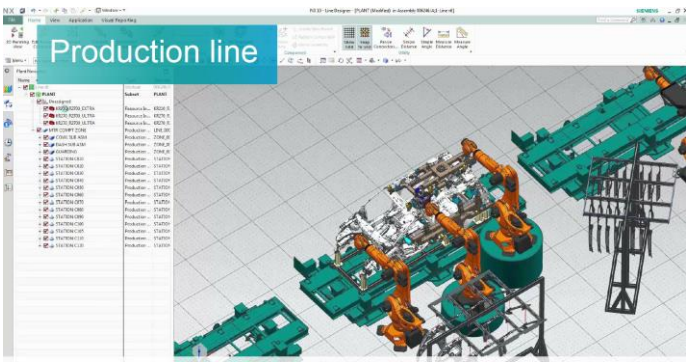
Source: Spirax Sarco

Exhibit 66: Rotork IQ3 actuator

Source: Rotork

More efficient manufacturing lines: Industrial automation is a key trend here, and we would highlight Siemens Digital Industries, ABB, Schneider and Hexagon as the leaders in our coverage. Manufacturing can also be made more environmentally friendly through more efficient tooling; Atlas Copco stands out in this regard.

Exhibit 67: Siemens Digital Industries



Source: Siemens

Exhibit 68: Hexagon automated 3D optical measurement

Source: Hexagon

Social and Governance

Consumers are increasingly concerned with the degree of social responsibility demonstrated by the companies they purchase from. This encompasses responsible environmental stewardship, respectable working standards and pay for employees and the wider supply chain, and an awareness of the broader importance that companies hold for the communities in which they operate.

Among our coverage we would highlight Coats as the standout in terms of emphasising corporate social responsibility (CSR). Indeed, Coats spent c40% of total capex on sustainability and CSR initiatives. Management views this not just as the ethically correct thing to do, but also as a strategic business decision, widening Coats' 'economic moat' to the long-tail of competitors in the global threads market. The company has extensive CSR goals, encompassing the use of natural resources, its environmental footprint, health and safety, employment conditions, human rights, ethics and reporting and transparency.

Exhibit 69: A sample of Coats' customers' strategy and environmental targets, illustrating the opportunities for Coats. Marrying CSR goals with traditional financial performance targets will be increasingly important as ESG investing grows in significance

	Strategy	Environmental Targets	Current Situation
Adidas	***"Speed Factory"*** **-** shorten lead times, increase flexibility and improve manufacturing quality & efficiency	Eliminate the use of virgin polyster by 2024. Get to 100% use of Better Cotton.	S/S '19 apparel line will contain around 41% recycled polyester. 93% use of Better Cotton (sustainable sources) in 2017 (BCI). >99% products free of PFC.
Nike	**NIKE's Consumer Direct Offense** aims to serve athletes faster and more personally at scale. Core to our strategy is the "Triple Double": 2x Innovation, 2x Speed, and 2x Direct.	NIKE's target is to increase the use of sustainable materials, including 100% usage of Better Cotton.	Use of sustained materials in 2017 was 30-33%. 75% of NIKE A&F products had at least some recycled material content in 2017. NIKE's Flyknit yarns are 100% recycled polyester, made by Coats.
Puma	***"To be the Fastest Sports Brand in the World"*** **-** Improve the product engine though innovation and continuous new product launches.	Use sustainable material alternatives for key materials: Increase bluesign certified polyester usage to 50% by 2020. Increase Better Cotton Initiative fiber volume to 50% by 2020.	40% usage of Better Cotton in 2017. 47% usage of bluesign polyster in Apparel. 99% products free of PFC.
Under Armour	***"Digitalisation"*** **-** Aims to revolutionise the industry: to disrupt, to do things differently via Data analytics, automation, innovation.	UA's vision is to manage, monitor, and report material consumption throughout the development and production stages. UA is working to direct more fully the origin and composition of the materials used to produce its shoes and apparel.	***"We are just getting started"***- UA are engaging with their suppliers to better understand the scope of environemental issues they face. **MicroThread** reduces dependence on elastane to create stretch in fabric.
VF Corp (Brand owner)	**2021 growth plan:** In response to fast changing markets it requires: More agility, to be more customer centric, improved quality and improved speed.	50% recycled polyester and nylon by 2025. 100% PfC-Free outdoor apparel by 2025. All cotton purchased by 2025 to be under a sustainable cottom scheme.	Leading the large-scale commercialization of circular business models through brand-led recommerce and rental initiatives.
H&M	In order to succeed when digitalisation is changing customer behaviour and the competitive landscape is being redrawn will require **speed, innovation and continued transformation**.	Only use recycled or other sustainably sourced materials by 2030.	In 2017 recycled or other sustainably sourced materials made up 35% (26%) of H&M group's total material use.
Inditex (ZARA owner)	**Global online sales**: all key markets same day / next day. All concepts to offer online sales globally by 2020.	**2020 strategic environmental goals:** Reach the Zero Waste to Landfill Objective by 2020. Increase manufacture of more sustainable products by using more sustainable fibres.	In 2016, Inditex released 1.38bn garments on to the market. 16.8m products were recovered for recycling.

Source: Company reports and presentations

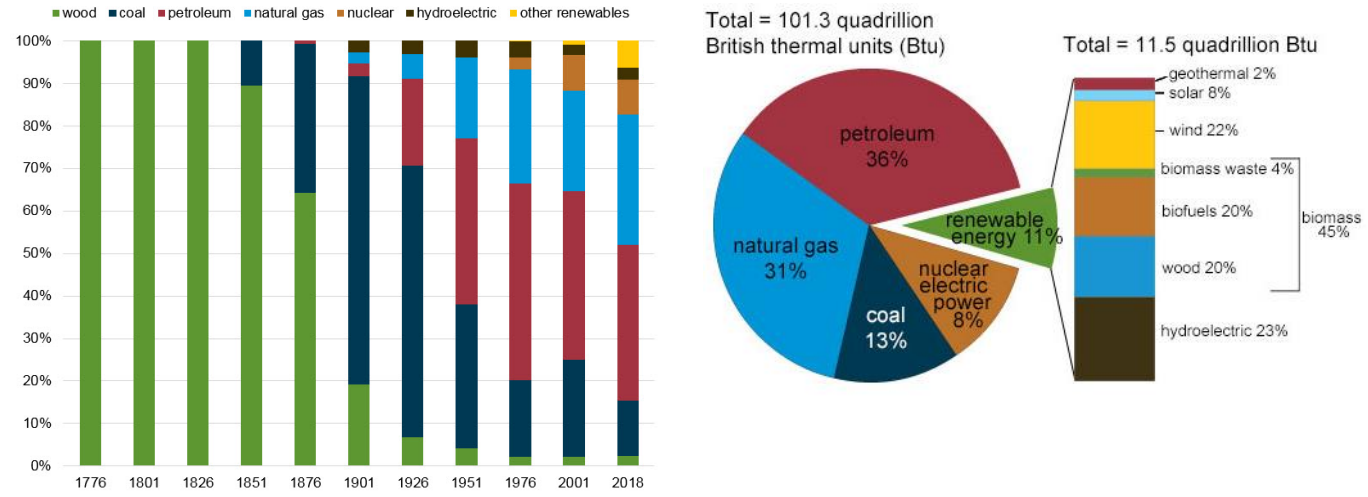
Renewable energy's growing importance

While still a small piece of global energy production, renewables are becoming increasingly important. Renewable energy is reliable and abundant, and will potentially be very inexpensive once infrastructure investments accelerate and technology improves. The list of renewable energies includes solar, wind, geothermal, hydropower and tidal energy, plus biofuels that are grown and harvested without fossil fuels. In the US, renewable accounted for ~11% of energy consumption, according to US Energy Information Administration. This number is projected to grow rapidly, especially given the significant benefits over nonrenewable sources that range from environmental to socio-economic and political. The list includes combatting climate change, reducing air pollution and improving public health, lowering and stabilizing energy costs, as well as improving the reliability and resilience of the energy system and supply. Resiliency also refers to resilience to weather-related impacts of climate change. For example, after hurricanes Irene and Sandy hit the US east coast in 2012,

locations within the New York metropolitan area began investing in renewables and microgrids to help prevent power shortages during future storms. The shift to renewables will have significant implications to the Industrials sector, especially those levered to the oil & gas end market.

Renewable generation will continue to grow over the next decade based on two drivers. First, the cost of energy for renewable generation continues to drop for both wind and solar. Second, greenhouse gas reduction will require increasing amounts of renewable generation. More announcements by states, cities, and utilities have a carbon-free target by 2050. Replacing carbon-based fuels with renewable generation plus meeting the expected growth in demand from electrification will drive the growth in renewables.

Exhibit 70: US Energy Consumption by Source



Source: US Energy Information Administration

Stock implications of renewable energy growth

Oil & gas equipment manufacturers and retail fueling pump providers are at risk longer-term. In the industrial sector, the companies most at risk to the world decreasing its reliance on nonrenewable energy sources include oil & gas equipment manufacturers all the way down to retail fueling pump providers. Oil & gas equipment includes pumps, valves, and compressors mostly used to transport the commodity and other miscellaneous equipment used in the upstream, midstream, and downstream sub-segments. Outsized oil & gas exposure in the Multi-Industry space include Flowserve, Emerson, and SPX FLOW (though the divestiture of Power & Energy is pending). While not 100% directly related, the other industry impacted is retail fueling (i.e., pumps at a gas station). As electrical vehicles become more prevalent and oil & gas reliance reduces, the retail pump manufacturers are likely to see disruption. Tailwinds for both industries require improvements in battery storage, so it is not unlikely that these industries could move in tandem. The two large retail fuel dispenser manufacturers are Fortive and Dover. Lastly, GE competes directly in the renewable energy space, primarily in wind, and continued growth in wind energy would be a direct positive for that segment of its business. We conclude with saying that the renewable energy industry requires investment, and investments create opportunities for companies to meet growing needs. Same is to be said with electric vehicles. Gas stations of today will need to materially transform to meet the changing landscape.

The ever-evolving waste stream

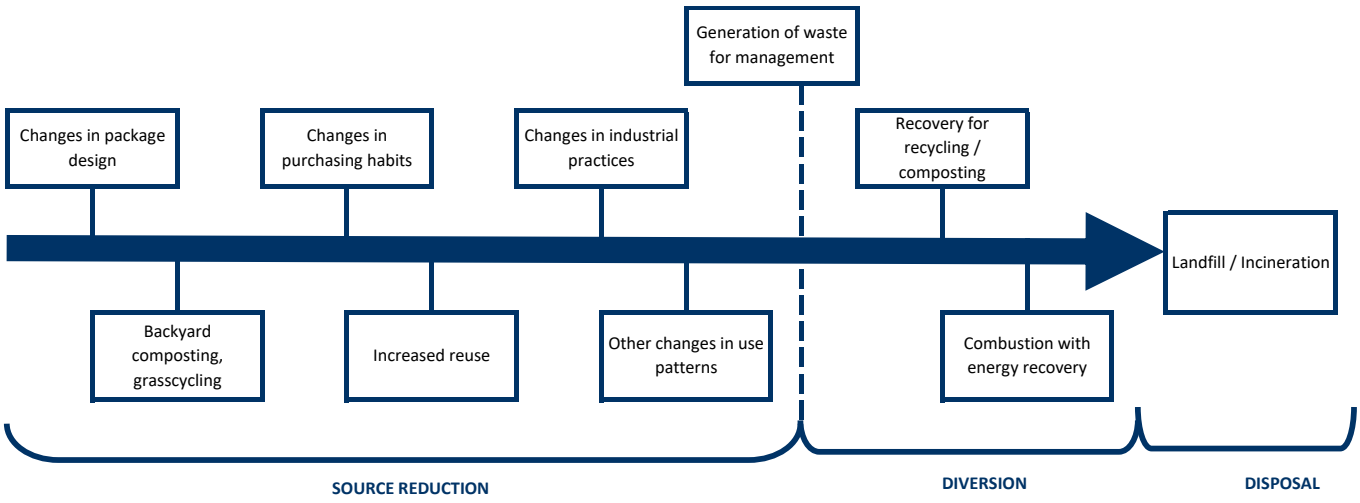
With the 1960s bringing about excess consumerism, waste generation per capita increased steadily over the next four decades from 2.68 lbs per day per capita in the US to ~4 lbs per day today. Increases in municipal waste generation are related to rates of urbanization, types and patterns of consumption, household revenue and lifestyles. North American per-capita income and average household disposable income have steadily risen since the 1960s, leading to increased household consumption rates and, as such, increased waste generation rates. However, over the past decade, the US has finally seen rates of waste generation holding on a per-capita level. Source reduction has been at the center of this change, which has arisen through both regulation and economic benefits. The key is that as the environment and the associated human impact becomes an increasingly prevalent issue, we believe the waste sector will remain at the forefront of this and will need to continue to adapt to changing social trends and expectations.

Changes to the waste stream

The waste stream is clearly changing because of regulation and increased public awareness on source reduction and waste diversion. These changes have meant that the waste industry is no longer operating as a service to discard waste material – but rather as an industry whose focus is increasingly to manage material recovery. While this is the overarching thematic within the industry, we see the three key drivers impacting the evolution of the North American solid waste industry as the following:

1) **Increased waste-generation volumes:** While waste per capita has been decreasing due to source reduction – waste volumes have increased as a result of population and economic growth. Changes to the amount of waste generation impacts the full cycle of the waste industry as collection is essentially the first point of contact within the waste stream.
2) **Increased waste diversion volumes:** Waste diversion has increasingly become mainstay. While waste diversion pulls volumes out of the disposal side of the business, the waste industry is increasingly connected and involved through recycling facilities, composting, and waste-to-energy reclamation.
3) **Flat waste disposal volumes:** Through both source reduction and increased waste diversion, disposal volumes per capita have declined. However, through population growth, total disposal volumes per year have remained relatively stable. Coupled with the waste industry becoming increasingly involved in the diversion side of the waste stream and landfill price increases, we think the industry is set to maintain growth rates.

Exhibit 71: Source reduction and waste diversion have impacted the waste industry



Source: ERG, RBC Capital Markets

The growing recycling trend

As mentioned previously, recycling really started gaining traction in the 1980s. Today, paper and paperboard products are the most recycled material in the waste stream by weight (42.5MM tons). New recycling facilities have been constructed with increased efficiencies. Material recovery facilities (MRF) have a wide array of equipment designed to sort and separate different kinds of recyclables and turn them into raw materials for manufacturers. Most MRFs process several different grades of paper, glass bottles, aluminum and steel cans and plastic containers.

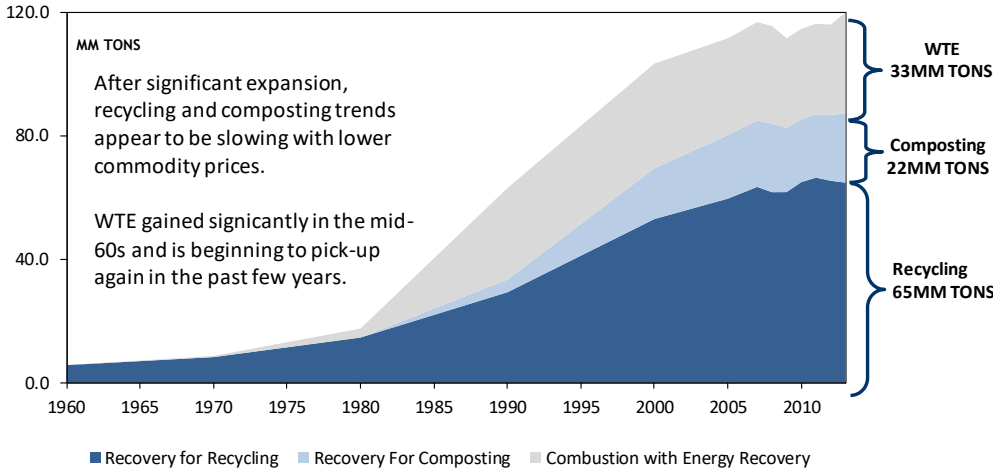
Waste-to-energy (WTE) looking for a comeback

WTE really took off in the 1990s following widespread and stringent emission limits set by the EU and the US. While the rate of growth in WTE has flattened in the past decade as introduced regulation has made WTE plants much more cost prohibitive, new environmental credits have helped to kick-start investment in WTE once again. We believe that MSW provides a solid input source for WTE as the cost per ton is low, whereas the energy content remains fairly high. Going forward we wouldn't be surprised to see waste-to-energy facilities continue to gain prominence, particularly as landfilling and incineration becomes further capacity constrained and increasingly regulated.

Composting has room to grow

Industrial composting systems are increasingly being installed as a waste management alternative to landfills, along with other advanced waste processing systems. Mechanical sorting of mixed waste streams, combined with anaerobic digestion or in-vessel composting, is called mechanical biological treatment and is increasingly being used due to regulations controlling the amount of organic matter allowed in landfills.

Exhibit 72: Waste diversion continues to increase



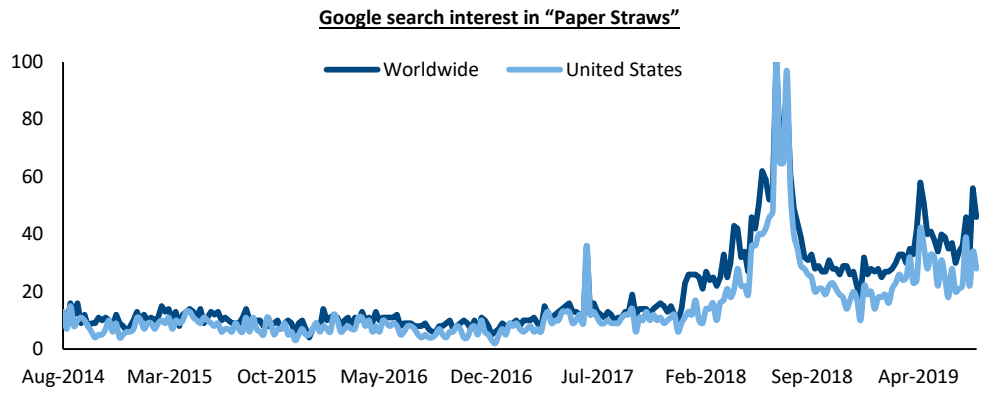
Source: EPA, RBC Capital Markets

The next paper straw?

We expect that shifting consumer preferences towards renewable and biodegradable goods will continue to rise. According to a 2017 study by The Conference Board (in collaboration with Nielsen), 75% of millennials would definitely or probably change consumption habits in order to reduce environmental impact vs. 46% of Gen Xers and 34% of Baby Boomers. By 2019, the Pew Research Center projects that Millennials will be the largest population cohort in the United States and that Baby Boomers will decline to 65% of the population by 2028. Demographic trends are likely to fuel the sustainability boom for the foreseeable future.

In 2018, consumer demand for the removal of plastic disposable straws increased significantly, leading to heighted demand for more sustainable paper straws. Despite the higher cost (in most cases) and currently poorer performance characteristics, demand has remained strong. The movement was sparked through grassroots environmental campaigns and celebrity endorsements. We believe that similar campaigns for other wasteful products are likely.

Exhibit 73: Global interest in paper straws surged in 2018 due to social media



Note: Google Trends data is presented as a % of peak popularity
Source: Google Trends, RBC Capital Markets

The final (plastic) straw – corporate action has driven adoption of paper straws

Corporations in the food service and hospitality industries have been key early adopters of paper straws as they are more sensitive to consumer preferences. Over time, we expect that the technology behind paper straws will improve, helping to support additional demand.

Exhibit 74: Food service and hospitality companies have been key early adopters of paper straws

Select companies that have stopped using single-use plastic straws

A&W Canada CEO Susan Senecal stands alongside art made from the company's remaining plastic straws

Note: Some companies listed above have only stopped using plastic straws in select markets
Source: Company filings, RBC Capital Markets

What's SUP? Global regulation will drive the next leg of paper innovation.

In March 2019, the European Parliament adopted The Single-Use Plastics Directive ("SUP"), which is an essential element of the *Circular Economy Action Plan* and is designed to stimulate the production and use of sustainable alternatives that avoid marine litter. SUP proposes a complete ban on select single-use plastic products for which alternatives exist on the market. These banned products include:

> *"Cotton bud sticks, cutlery, plates, straws, stirrers, sticks for balloons, as well as cups, food and beverage containers made of expanded polystyrene and on all products made of oxo-degradable plastic."*

We expect the directive to have a profound impact on consumption habits in the EU, similar to the 2015 Plastic Bags Directive. Globally, we are seeing similar bans take place at both the national, state/province and municipal levels. For example, in 2018, both India and Taiwan announced bans on single-use plastics (India by 2022 and Taiwan by 2030). In North America, both Seattle and Vancouver have passed bans on single-use plastics, with many other cities considering similar proposals.

Where we see opportunity

With the collective action of individuals and a growing concern for environmental waste, we see a number of opportunities for paper to replace or augment existing plastic technologies. Below, we highlight potential movements in toilet paper and water bottles.

1) **Sustainable toilet paper –** In the tissue segment, recycled away-from-home napkins became ubiquitous during the late-2000s, as companies such as *Dunkin Donuts* adopted recycled fiber napkins in 2009. A 2019 NRDC whitepaper highlighted the substantial environmental benefits of recycled tissue, including less bleach, ½ the water usage, 1/3 the greenhouse gases, and less of an impact on wildlife. In 2012, Cascades Inc. had introduced a "Moka" unbleached, recycled toilet paper product, which we believe was ahead of its time. We view recycled toilet paper as an easy environmental win.

Exhibit 75: Substituting to recycled toilet paper would have a significant environmental impact

Source: Cascades, RBC Capital Markets

1) **Plant-based bottles –** According to the International Bottled Water Association ("IBWA"), single serve PET plastic bottled water containers have a recycling rate of only 33.4% and represent 0.92% of all plastic produced in the United States. Plant-based plastics represent one potential solution to the growing plastic problem. Canada-based *Origin Materials* is commercializing carbon-negative, recyclable, 100% plant-based polyethylene terephthalate ("PET") plastic along with its partners Nestlé Waters, Danone, and PepsiCo. PET plastic is the primary material used in water bottles globally. The Origin Materials team uses waste from sawmills (largely chips and sawdust) to derive cellulose, which is chemically converted to input chemicals for the bottling process. The companies plan to sell the bottles beginning in 2022.

   Another plastic water bottle replacement solution in development is the paper water bottle. In April 2019, BillerudKorsnäs and ALPLA formed a joint venture to develop a fully bio-based and recyclable water bottle. The BillerudKorsnäs team has leveraged their expertise in pulp and chemistry to optimize the bottle design properties. The Paper Bottle Project officially began in 2015, and although the JV hopes to start pilot production in the near future, there is currently no firm timeline to production. In terms of commercial adoption, Carlsberg (also a minority partner in the JV) ran advertisements in 2015 highlighting the sustainability features of the bottle.

Exhibit 76: Carlsberg utilized the paper water bottle design in a 2015 advertisement

Source: Carlsberg Breweries A/S

Building coalitions to solve multi industry problems

LyondellBasell is a good example of a corporation taking the lead in building multi-industry partnerships to reduce plastic waste. LYB launched the Alliance to End Plastic Waste, in Jan. 2019. Since then LYB has increased membership to 39 companies worldwide (as of 8/1/19) across the value chain, including brand owners, chemical companies and waste handlers. The next group the alliance is working on incorporating is the retailers.

AEPW's main focus areas are:

- Infrastructure development to collect and manage waste and increase recycling;
- Innovation to advance and scale new technologies that make recycling and recovering plastics easier and create value from all post-use plastic;
- Education and engagement of governments, businesses and communities to mobilize action; and
- Clean up of concentrated areas of plastic waste already in the environment, particularly the major conduits of waste, like rivers, that carry land-based plastic waste to the sea.

AEPW members have committed over $1.0B with the goal of investing $1.5B over the next five years to develop and bring to scale solutions that will minimize and manage plastic waste and promote post-use solutions. We believe that with this bringing together of the entire value chain, the Alliance can apply the expertise of each sector, and leverage the collective resources and insights from each member in a global coordinated effort.

In the chart below we see the evolution of annual global plastic production, measured in tonnes per year. This is shown from 1950 through to 2015. Global annual product has increased nearly 200-fold since 1950, reaching 381M tonnes in 2015. This is equal to cumulative plastic production of ~8B tonnes of plastic.

Innovation and its implications for the future of farming

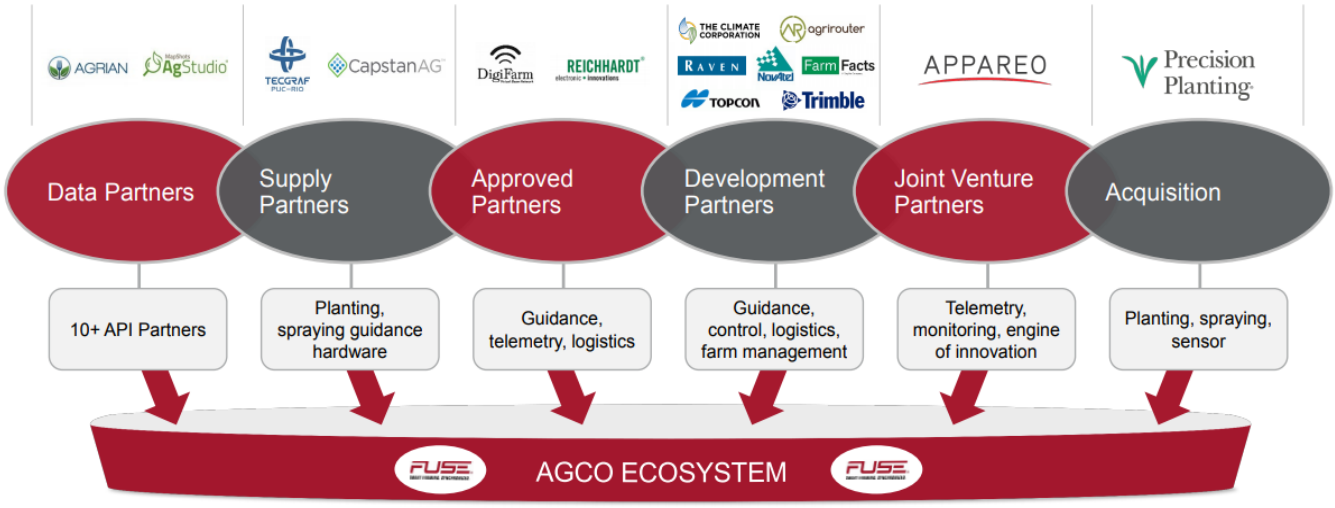
AGCO, unlike some peers, has taken an open approach for its Fuse smart farming technology platform. The approach encourages collaboration from numerous contributors and supports data collection/utilization across equipment nameplates. By utilizing an open network with varying types of partnerships (i.e. farmers, agronomists, seed companies, fertilizer companies, co-ops, etc.) it allows easy flow of information and sharing of ideas to drive innovation. Examples of data collected and shared includes diagnostics to prevent machine downtime, nutritional value of soil, crop health during the growing season and weather patterns to better

predict rainfall. For its part, AGCO's decision to open/share lowered its initial investment while increasing its speed and agility.

Through its Fuse technology platform and other smart farming initiatives, AGCO has a stated goal of delivering farmers a 20% improvement through a five-year crop cycle. It targets improvement in revenue, including more efficient planting, fertilizing, harvesting, and weed/pest control; and cost, including improvements in machine management, less downtime, better fleet management and logistics.

In contrast, Deere's MyJohnDeere platform, which helps agricultural producers optimize the management of production data, equipment information and farm operations, is meant to be used on JD equipment (with very few exceptions). The software analyzes data through sensors on Deere equipment and is shared across stakeholders to help farmers manage their fleet, reduce downtime inefficiencies, and save on fuel costs.

Exhibit 77: Fuse Ecosystem

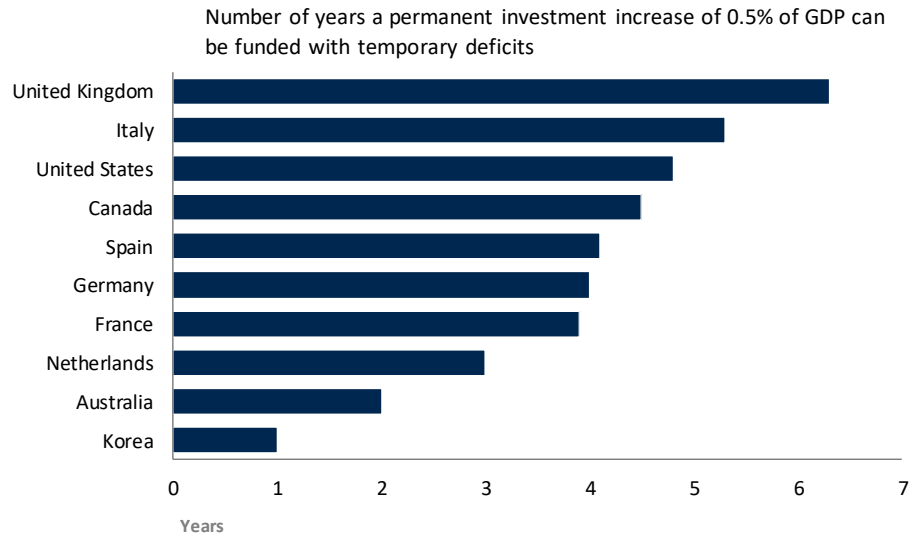


Source: AGCO 2018 Analyst Day Presentation

Banking on an infrastructure buildout

Aging and deteriorating infrastructure in developed countries remains a key priority for politicians and the voting public. Canada and the US are both pursuing fiscal stimulus with funding already in place and bigger plans being put into place. The Organization for Economic Co-operation and Development (OECD) has noted that more than half of developed countries have the balance sheet room for a multi-year permanent investment increase of 0.5% of GDP. However, while public funds are expected to fund $1.2T in infrastructure investments, there is still a $0.8T funding shortfall anticipated. This is why private-public partnerships, which were once considered as an alternative project financing structure, are becoming more mainstream and no longer just used extensively in Canada.

Exhibit 78: Lots of room for fiscal stimulus for public works projects in developed countries

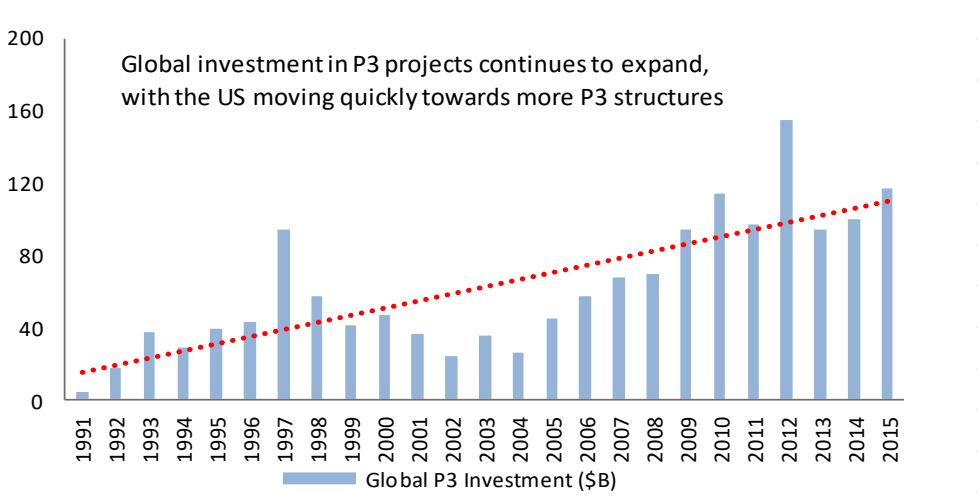


Source: OECD

Private-Public Partnerships - A win-win

The market for public-private partnerships in the US is gaining ground due to the public funding shortfall of financing needed infrastructure projects. This creates asset ownership opportunities, particularly for SNC. According to PwC, investors are interested, capital is plentiful, and the federal government is increasingly involved in the US. Management at SNC is looking to expand the company's infrastructure P3 business into the US. Already, more P3 projects in the US are entering the pipeline and reaching financial close. And it's noteworthy that these projects are spreading to new sectors and states. Just in 2017, there have been over 26 P3 deals in a total of six states (Texas, Virginia, Florida, NY/NJ, Colorado, and Pennsylvania).

Exhibit 79: Growing opportunity for ownership of infrastructure assets



Source: RBC Capital Markets, World Bank

Living smarter

Google-parent company Alphabet (NYSE: GOOGL) is currently in discussion with the City of Toronto to develop a Smart City through its Sidewalks Labs division. The company unveiled an

ambitious plan that would see a parcel of land in downtown Toronto developed into the world's first Smart City and could pave the way for similar projects in other large markets. Urban planning could be in significant shift in the coming years as the Smart Cities, or elements of the concept, become more prominent. Smart Cities would leverage scanners and other techniques to collect data from citizens which would be leveraged to operate more efficient cities (i.e. reduce traffic and pollution, improve safety, manage resources more effectively, etc.). While such projects are in the early innings of development and are likely to remain controversial, the potential widespread acceptance in smart/connected cities will likely have implications for urban infrastructure construction projects going forward. This trend could be accelerated by a shift towards urban living as millennials have demonstrated a reluctance (compared to previous generations) to migrate to the suburbs and place greater emphasis on sustainability.

Consolidation in transportation could be coming

Off to the races; the potential impact from consolidation at the railroads. We believe that consolidation at the railroads would drive significant improvements in operating efficiency reflecting increases in fluidity due to less interchanges. Looking at the UNP and CSX network maps below, we can see that if UNP is shipping to an area in the Eastern US not covered by their network they must interchange with CSX (or NSC) to move the container to its end destination. However, if UNP and CSX were to hypothetically merge, both railroads would increase their reach while significantly improving fluidity and our view is that this would drive much larger shareholder returns. However, any merger in the railroad industry would draw interest from the regulator and likely encounter resistance from labor as well as shippers as we discuss in more detail below.

Exhibit 80: Railroad M&A would reduce interchanges while improving reach

UNP network map **CSX network map**

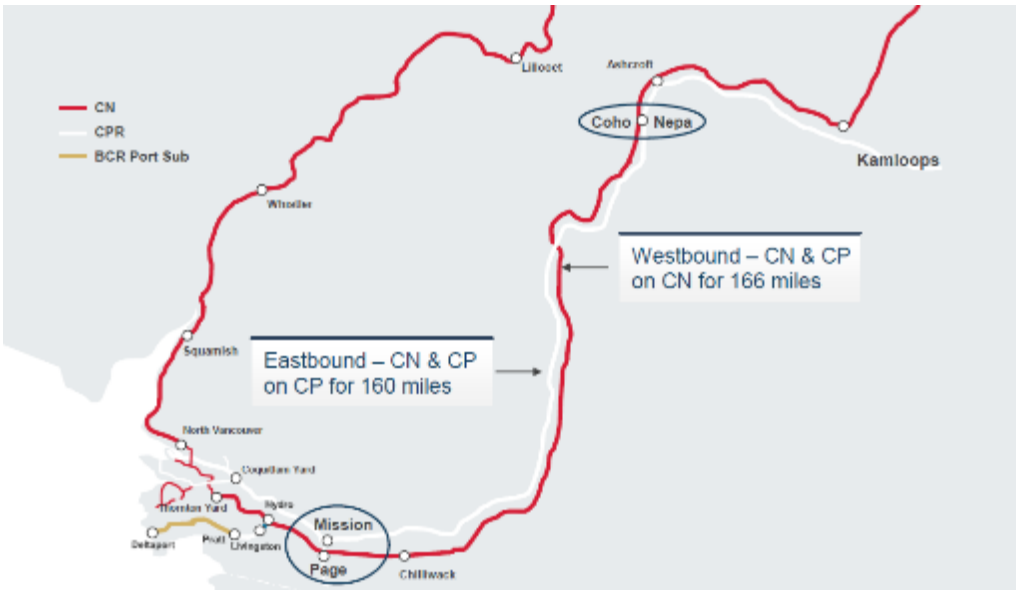
Source: Wikipedia

Regulators would need to see congestion or threat to economic growth to allow M&A. We suspect that any M&A in the rail industry would face significant push-back from labour unions, shippers and the regulator. The labour unions would likely resist fearing probable job losses and shippers would push back suspecting that decreased competition would result in rate increases. However, while we believe the concerns of labour and shippers are valid, our view is that the major obstacle to M&A would be from the regulator. We think that the regulator would view an already consolidated industry (currently 7 Class 1 railroads with most areas only served by 1 or 2 railroads) becoming smaller as a threat to competition due to the lack of viable alternatives for many shippers. We believe that the regulator would need to see congestion on the railroads that was significant enough to affect economic growth prior to approving any M&A and that the regulator would need to believe that consolidation was the only solution.

So while we do think that M&A would drive large shareholder returns, we think that mergers are likely to draw significant resistance. As such, we think cooperation, as opposed to M&A, is much more likely.

While M&A may not be on the horizon at the rails, we expect increased cooperation to improve efficiency. As we highlighted above we believe that railroad M&A would encounter resistance from many parties, however, we note that cooperation among the rails has already been successful and we expect joint ventures to increase in importance going forward. For example, CNR and CP operate a directional double track corridor in the Fraser Canyon, which allows both CNR and CP trains to run Westbound on CN track into Vancouver and Eastbound on CP track out of Vancouver (see Exhibit 81). This partnership has improved fluidity and reduced congestion in Vancouver with relatively little capex. More recently, in August 2019, CNR and CSX partnered to increase intermodal service into Montreal and Toronto from the US East coast ports – this partnership should allow containers to reach Montreal and Southern Ontario much more easily and should allow the rails to compete much more effectively against truck in these lanes. Looking ahead, we see these types of partnerships benefitting all the railroads via improved operating efficiency and increased capacity due to better asset utilization.

Exhibit 81: Cooperation between CNR and CP improves fluidity in Vancouver



Source: CNR Company reports

Consolidation in trucking likely to accelerate as scale becomes a competitive advantage. We expect scale to become more important as companies invest in information technology and as e-commerce growth increases volume as well as service requirements. Currently the US trucking industry is very fragmented with the largest trucker, J.B. Hunt, accounting for less than 2% of total industry revenues according to IBISWorld. Our view is that information technology will become increasingly important and will act as a competitive advantage to firms best able to leverage it – we expect that larger firms with strong cash flow generation will be better able to invest leading to larger firms taking increasingly more market share. Additionally, as e-commerce and same-day delivery become more common we expect that last mile networks operating at large scale will be more competitive, thereby pushing smaller players out.

Theme V: Escalating Uncertainties

Change is occurring on a daily basis, and this change will significantly impact the direction technology is headed by 2025. This rapid evolution is fueling the uncertainty that surrounds the industrials space from a government intervention, regulation, environmental, and competitive standpoint, alongside many others. Technology has the ability to reinvent the way society will function by 2025, as the space navigates through a number of developments and challenges throughout that time horizon.

What you need to know

Alongside the other key themes we have discussed throughout this report, technology has both the ability to be a significant disruptor as well as to be the one to be disrupted. As Director of National Intelligence James Clapper told Congress in 2016, "unpredictable instability is the new normal." We will examine the impact of some of these uncertainties by taking a deeper dive into the regulatory environment and evolving global trends such as climate change and urbanization.

Key Escalating Uncertainties developments include:

Government Intervention/Regulation: Regulation in the industrial space is becoming increasingly focused on: 1) Climate change, 2) Labor laws, 3) Sustainability, and 4) Resource protection. One of the larger uncertainties for the future of industrials is increased environmental oversight, as planetary preservation becomes more and more intertwined with the daily life of individuals all around the world.

Global urbanization: Some debate still exists over the cyclical vs. secular trend toward urbanization, but the fact is that urban populations have continued to grow in recent years, led by millennials and older generations aging in place. As younger generations are transitioning into becoming the largest adult demographic cohort, public transportation capabilities and global infrastructure spending in developed and developing economies will likely correspond with the goods and services that they desire.

Resource scarcity: Populations around the world are increasingly facing one of the most urgent crises gripping the planet today: water scarcity. Cities are urgently adopting new solutions to build secure, sustainable, and resilient water supplies and infrastructure, including water desalinization and new methods for water reuse. Additionally, hunger continues to be a global epidemic. To help meet rising food requirements amidst limited natural resources (arable land, water), we anticipate continued adoption of smart farming and advances in bioengineering.

Companies Highlighted: WSP Global, Stantec, Ford, GM, Volkswagen, PPG Industries, LyondellBasell, Sealed Air, Crown Holdings, Ball Corporation, Ardagh Group, PepsiCo, Exxon Mobil, Dow, IPL Plastics, Evoqua Water Technologies, Danaher, Pentair, Xylem, Flowserve, AquaVenture Holdings, AGCO Corporation, Deere & Company, Norbord, Mercer International, Rayonier Advanced Materials, Union Pacific, Google

Changing the way we build

Climate Change

While climate change has had and will continue to have wide ranging effects across multiple industries, there are potentially some very profound effects on the housing industry. Rising sea levels are one of the hallmarks of climate change and will potentially pose serious risks to some of the largest cities in the U.S. Major metropolitan areas such as NYC, New Orleans, Miami, Los Angeles and San Francisco are all at risk for significant flooding over the coming decades. In many markets (like New Orleans), entire stretches of land could be submerged. Proximity to water has long been an attractive feature for homeowners, but now the very thing that made these cities desirable could soon make them undesirable…or underwater. According to Zillow Research, 803k homes ($451B value) will be at risk of flood destruction by the year 2050 – just 2% of these at-risk homes were built after 2009.

In addition to the rising sea levels, extreme weather events have seemingly become more common (think Hurricanes Harvey and Sandy, the California wildfires, or this year's record rainfall in the Midwest), forcing construction companies to look for better construction materials and forcing governments to consider revising outdated building codes. This can still be met with resistance, but change is inevitable. We think that the combination of newer materials and updated standards should benefit building products companies as these changes drive new demand. Areas that are prone to Hurricanes will need greater structural support and better roofs, drought-stricken areas will need less flammable material, and areas across the country will need more energy-efficient homes to contend with more volatile weather patterns. At the end of the day, a high degree of spending will be required in order to repair damages from catastrophes, renovate homes to withstand more severe weather conditions, and build new homes that have even more advanced weather resistant features. Our sense is that building products companies will be net beneficiaries (insulation, windows, siding, and roofing in particular), while consumers and homebuilders bear the burden of higher costs.

Changing building codes

Building standards are likely to see drastic changes over the coming years as one of the more effective ways to fight carbon emission. Residential electricity alone produces over 10% of the total US carbon emissions. Within this, heating and cooling account for over half, while other large appliances such as refrigerators and washing machines also account for a significant portion. Newer building standards will likely be focused on energy conservation through better insulation and more energy efficient materials (see California's net-zero mandate as an example). However, these new standards are likely to raise the cost to build a house, ultimately raising the price for homebuyers. On the products side, newer, more energy efficient materials will need to be adopted. Products from roofing to insulation to windows and doors will likely have to adhere to stricter regulations. Even basic building materials such as cement may be forced to adapt to stricter production standards.

Tariffs

Political uncertainty, especially surrounding tariffs and increased nationalism have already begun to impact building product companies and their supply chains. In order to avoid increasing tariffs, many of them are already being forced to reshape supply chains, shifting production from China into other countries. Plumbing fixtures, lighting, cabinets, appliances, and flooring all have significant supply chain exposure to China.

Immigration Policy

Stricter immigration policies also have a significant impact on the homebuilding industry because of both the current shortage of skilled laborers and for longer-term demand trends. Currently the U.S. is not producing the amount of skilled laborers demanded by the

construction industry, and without immigration, this shortage is likely only to worsen. Labor has been an increasingly expensive piece of home construction and until there is a greater supply of the necessary laborers, the inflationary pressure is likely to remain a sizable headwind. Longer-term on the demand side, U.S. birth-rates are falling and the baby-boomer generation is aging. While much optimism exists about the potential for Millennials who have delayed marriage, having children, and purchasing homes to lift the housing market as they continue to age into prime home-buying years, longer-term demographics are less favorable. Without sufficient immigration, the U.S. housing market would likely see slowing growth as it grapples with a slower growing (or potentially even shrinking) population.

Urbanization

Some debate still exists over the cyclical vs. secular trend toward urbanization, but the fact is that urban populations have continued to grow in recent years, led by millennials and older generations aging in place.

Urban areas tend to already be well built, with much less land for further development, which leads to higher land prices. These areas also tend to have higher labor and material costs (and more restrictive zoning) further pressuring the cost to build. These factors have helped drive urban home prices higher, making large cities increasingly unaffordable for many people.

Meanwhile, longer-term desirability of living in tertiary markets far from job centers, where land remains relatively available and more affordable for production homebuilders to build, is a question.

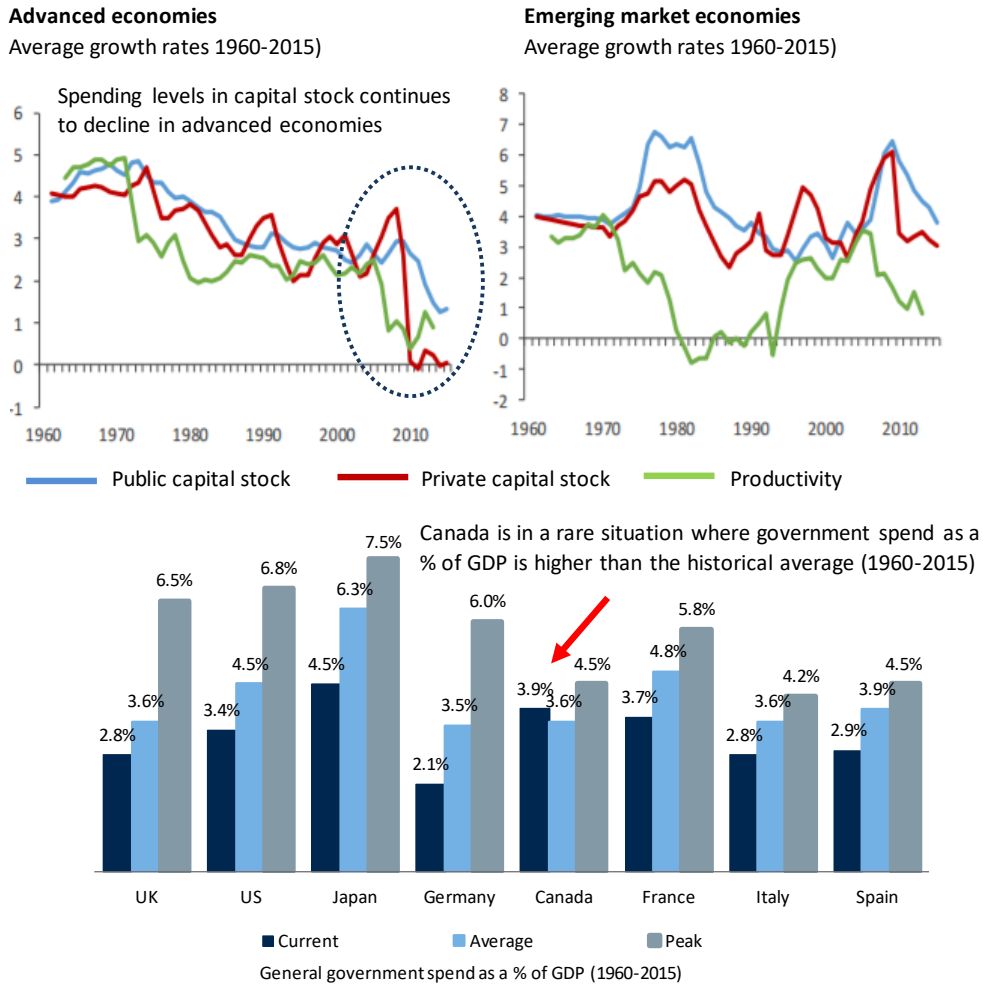
Affordable Housing

Affordable housing has become a hot topic in the current political climate as labor and land shortages are driving up home prices. Restrictive building codes and zoning laws are also contributing to rising home prices. As a result, lower income workers get pushed out of their neighborhoods as the costs simply become too expensive. While most politicians call for a need for greater affordable housing, homebuilders are already struggling to profitably build lower priced housing given high land, labor, and regulatory costs. Further, builders run into challenges because land is often not zoned for multi-family developments that would be required to build affordable housing. However, changing zoning laws is also a political sticking point because the increased supply tends to lower the value of current property, thereby hurting current homeowners. Ultimately, greater density (including vertical development) is likely needed to help combat affordability hurdles.

Population growth = urbanization = increased infra spending

The world continues to be a dynamic and evolving place. The need to support human growth is immense with global population levels expected to exceed 9.5B by 2050 (according to the World Bank) – an increase of ~2B from where we are today. The other key trend is the urbanization movement. Reports from the World Bank suggest that we are going to have to build 5 cities the size of Beijing every year for the next 20 to 30 years to cope with urbanization. There is a massive amount of infrastructure, utilities, and buildings that would be required to support this growth. We view the E&C sector to be in a position to capture the upside of these trends, which we see playing out not only over years, but over decades. The key is that infrastructure spending has been declining despite these trends, setting the stage for what is set to be a significant influx of public and private funding to support these burgeoning megatrends.

Exhibit 82: The need to build infrastructure is growing after years of underinvestment

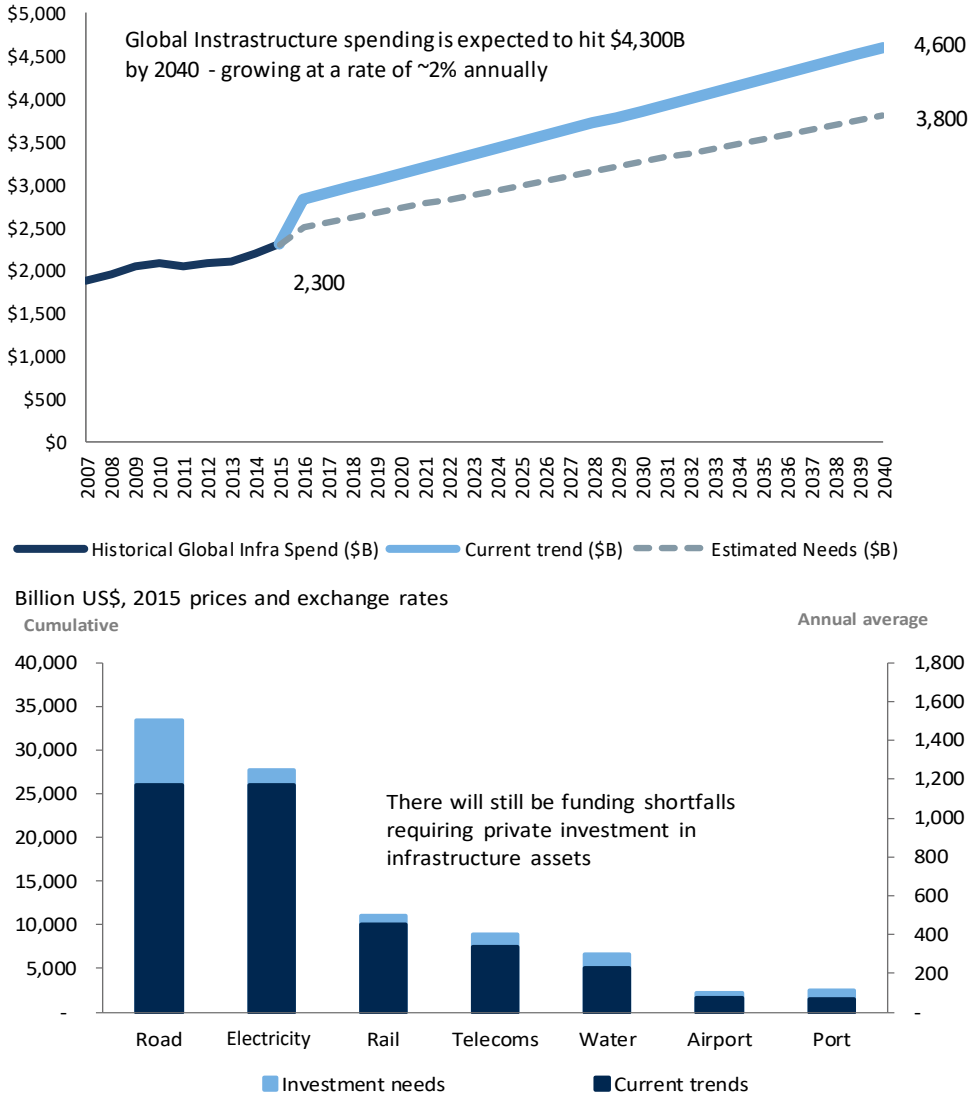


Source: IMF, RBC Capital Markets estimates

Did someone say super-cycle?

Our Industry survey in late 2017 indicated positive near-term expectations around public funded infrastructure spending in Canada. And while the US infrastructure funding plan at the federal level has yet to be put into place, project funds are beginning to flow at the state and municipal level through ballot initiatives. Add in the need to replace deteriorating infrastructure in developed countries globally, as well as new infrastructure needs in emerging markets, and we could quite possibly be at the forefront of a multi-year infrastructure super-cycle.

Exhibit 83: We could be at the cusp of a multi-year infrastructure super-cycle

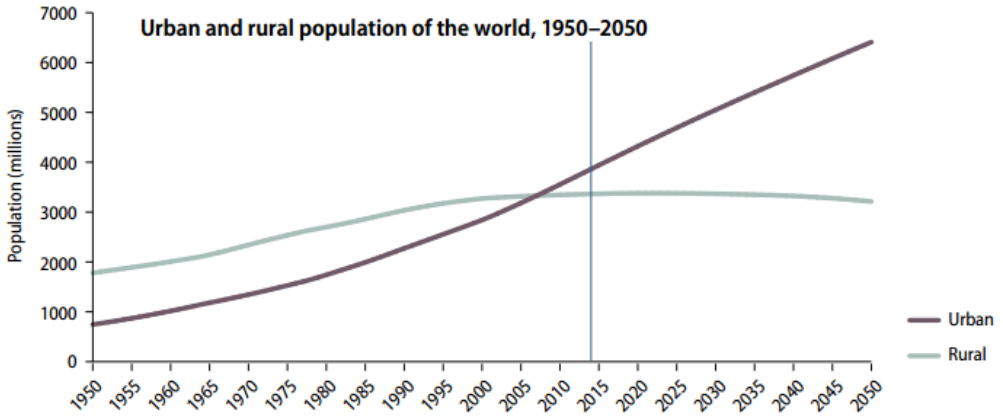


Source: Oxford Economic, RBC Capital Markets

Home in the burbs…no thanks

Yes, millennials are changing how we live and how we design our urban landscape. Their social life and work life are converging and they want to live in an urban area where everything is at their fingertips. We see this trend as a positive for both WSP and STN, with 30% and 20% of revenues coming from the property and building sector, respectively.

Exhibit 84: Urbanization is set to continue on a global scale



Source: UN

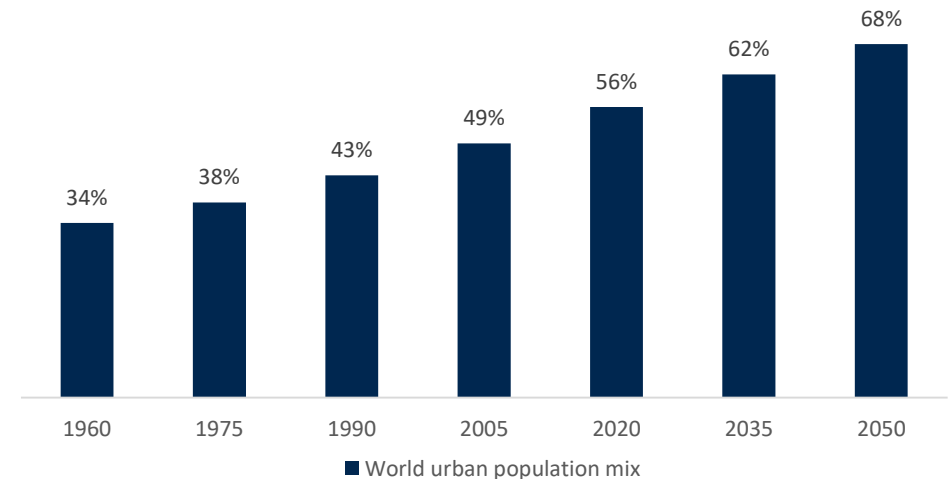
Multiple secular trends set to revolutionize the auto industry

The automotive industry is facing a transformative shift given the rise of key secular trends such as autonomous driving and electrification. This is occurring at a time when urbanization is accelerating, which is motivating the introduction of multiple new forms of mobility to aid with this increased level of congestion. While the confluence of these trends is revolutionizing the way we think about not only vehicles, but also transportation in general, it is also causing the future of mobility to appear increasingly unclear.

Urbanization threatens legacy metropolitan transportation systems

The idea of urbanization is nothing new. In 1960, it is estimated that only ~34% of the world's population lived in urban areas. By 2007, that had become a majority with ~51% of the world's population estimated to live in rural settings. This shift is only expected to accelerate as the United Nations projects ~68% of the world's population will live in urban areas by 2050.

Exhibit 85: Share of world population living in urban areas



Source: United Nations, RBC Capital Markets

In an effort to support this heightened level of urbanization, increases in public transportation capabilities have coincided with the recent rise of alternative mobility options (i.e. ride-

sharing), which has resulted in higher levels of urban congestion. As a result, we have seen the emergence of micro-mobility (e-scooters, e-bikes, etc.), which tries to solve last mile mobility and provides an alternative to traditional transportation.

Micro-mobility is a key prong to making the concept of multi-modal transportation successful, which is achieved by combining different transportation solutions (including personal car ownership, ride-sharing, AVs, public transport and micro-mobility) to yield the most efficient trip. However, this only works if this can be done cohesively to reduce friction in transportation and people's lives. The idea of multi-modality may seem somewhat nebulous and distant, and it could be a while before it meaningfully changes transportation as we know it. But to his credit, this is a concept Ford CEO, Jim Hackett, has been on top of, calling it "The Living Street" and how Ford wants to manage the Surface Transportation System. If multi-modality takes hold, it has potentially large ramifications for existing automakers especially considering research shows that nearly half of US trips are less than 3 miles. If an efficient, seamless, inexpensive trip can be planned and consumer preferences shift, there could be less need for vehicles that are quite frankly over-engineered to solve last mile mobility.

However, while more and more unconventional transportation methods and services are likely to continue to emerge (from both technology companies and traditional auto OEMs), the largest influence over what the future of urban transportation will look like likely lies with the cities themselves. This could prove to be a significant headwind for the pace at which cities adapt a more modern transportation model given each municipality differs significantly. Further, some changes (such as putting in bike lanes) seem relatively rudimentary and aren't huge investments, but cities can be reluctant to implement changes and usually want to see some proof of concept or payback before making an initial investment.

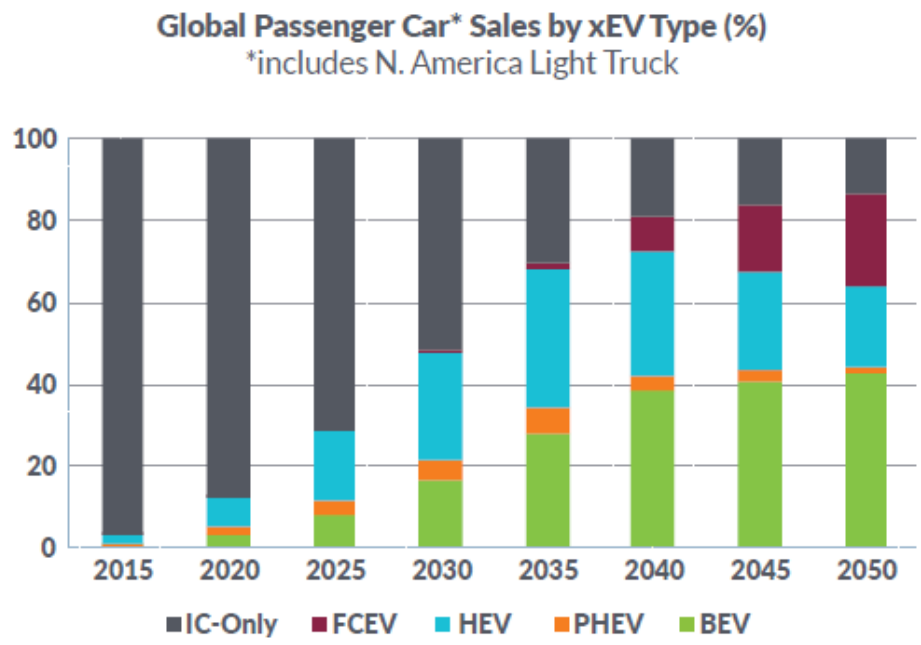
As such, cities lack the data and capabilities to make the right decisions related to modern mobility as current city plans are based on models that are still somewhat stuck in the past. This is increasingly concerning given the growing number of alternative transportation systems and services (a phenomenon that likely only accelerates) is contributing to increased complexity as there is little to no communication between the various offerings. While the advancement of urban transportation presents a significant economic opportunity, we believe an eventual solution is more likely to be accomplished in the private sector versus by the cities themselves.

Inevitable transition to electrification carries unclear timeline

While the transitions to electrification and autonomous appear inevitable, the timing associated with these shifts remains very much unclear, which is casting significant uncertainty over the near- to mid-term prospects of the industry. The shift to autonomous will likely be prolonged given regulatory headwinds and still unproven technology, but the electrification transition is very much underway.

Global sales penetration for xEVs (defined as a vehicle with any type of electrified powertrain from mild hybrid to battery electric vehicle) grew from 4% in 2017 to 5.5% in 2018 driven largely by sales of battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), both of which grew by more than 60% y/y in 2018. LMC Automotive expects xEV penetration to grow to nearly 30% by 2025 driven largely by more stringent emissions standards in China and Europe.

Exhibit 86: LMC xEV penetration forecast



Source: LMC Automotive, RBC Capital Markets

This year in China, automakers must have NEV credits (earned or bought) equal to 10% of the conventional passenger vehicle market, which rises to 12% in 2020. In Europe, automakers must hit CO2 levels of 95 g/km (~57 MPG) by 2021 with a 15% reduction (relative to 2021) by 2025 or 81 g/km (~67 MPG) and a 37.5% reduction (relative 2021) by 2030 or 59 g/km (~92 MPG). Failure to comply with these targets results in steep penalties. For example, in China, the government can deny approval of new vehicles that don't meet standards until the NEV deficit is offset. In Europe, automakers must pay €95/vehicle for every g/km by which they exceed their target.

So, OEMs clearly have significant incentives to transition their portfolio to xEVs as the CO2 regulations are effectively forcing automakers to more PHEVs and BEVs. However, the other side of the equation is that battery electric vehicles remain expensive as we believe many BEV programs are currently dilutive or don't make money. While costs should eventually come down as OEMs generate scale (helped in part by the multitude of recent OEM partnerships, a trend that likely only accelerates) and battery costs continue to decline, customer adoption and interest in EVs remains very much unclear. Until consumers view the xEV equivalent as financially viable, there is a chance they could trade range/size and downsize back to smaller vehicles (which are less profitable for OEMs) or hold onto their current vehicles longer (which would weigh on new vehicle demand).

As such, OEMs are put in a difficult position as they work to position their portfolio to meet increasingly strict emission standards and thus avoid fines, but also try to cater to the unknown consumer tastes associated with EVs. The strategies differ by OEM with some (GM, VW) electing to put their investment dollars behind BEVs even though adoption is likely further out, while others (Ford, Toyota) placing investment dollars on PHEVs/HEVs, which they believe will be an interim solution as the electrification ramp progresses.

From a supplier perspective, the uncertainties are perhaps even more daunting as their operating models are directly tied to vehicle production. Given more and more of the programs on which suppliers will be taking a chance on will be for xEVs, which haven't been

produced en masse yet, the uncertainty likely means that there will be greater than usual variability in new powertrain program launch curves vs. a traditional program (which can weigh on margins for both OEMs and suppliers). Additionally, given the increased costs of producing xEVs for OEMs, we could see automakers request more help from suppliers as they attempt to deal with the cost overruns associated with complying with more stringent emission standards.

Overall, the increased volatility and lack of visibility of xEV adoption is likely to create significant potential margin headwinds across the automotive value chain moving forward. OEMs are essentially being forced to pivot their portfolios towards more xEVs as a result of stricter emission standards, despite xEV consumer demand being largely unknown. This creates a significant overhang on the volume outlook and expected pace of adoption for electric vehicles as the industry attempts to navigate through this inevitable transition for which there is no precedent to rely on.

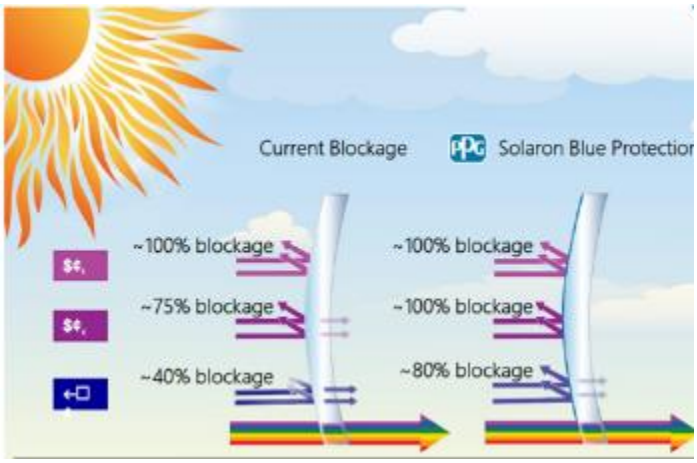
Sustaining a profitable and innovative future in packaging

PPG is an example of a company that is addressing social issues and solving problems through innovation, while making the world a more sustainable and profitable planet. The companies that will lead us into the future are figuring out ways to make their products eco-friendly, profitable and safer. A win-win for all parties involved. PPG is making the capital investments in technology and people to create mutual-value for customers and the environment, while at the same time improving product performance. PPG's window technology, called Solaron Blue Protection, enhances crew and passenger safety by reducing exposure to ultraviolet and high energy (HEV) light. Solaron blocks over 99% of UVA and UVB rays and over 50% of high energy visible blue light without loss of optical integrity. This technology is responsible for reducing harmful solar rays that can cause cancer and damage to the retinal structure in the eye. For reference, studies have compared sitting in a pilot's seat at 30,000-ft altitude for ~ 1 hour is equivalent to spending 20 minutes inside a UVA tanning booth. Further, PPG's aircraft windows not only protect crew/passengers from harmful radiation but also protect aircraft interiors against solar radiation that can raise the temperature inside an aircraft which then requires higher fuel consumption to maintain a standard temperature. This is an example of a company that is leveraging technology to reduce its customers' carbon footprint and building a safer workplace.

Another way PPG is using technology to improve environmental, health and safety impact is through their Chrome Free Wash Primer and Electrocoat Primer, a product that:

- Supports environmental sustainability;
- Reduces usage of corrosive, toxic and flammable materials;
- Chrome free product and environmentally compliant; and
- Virtually 100% material utilization.

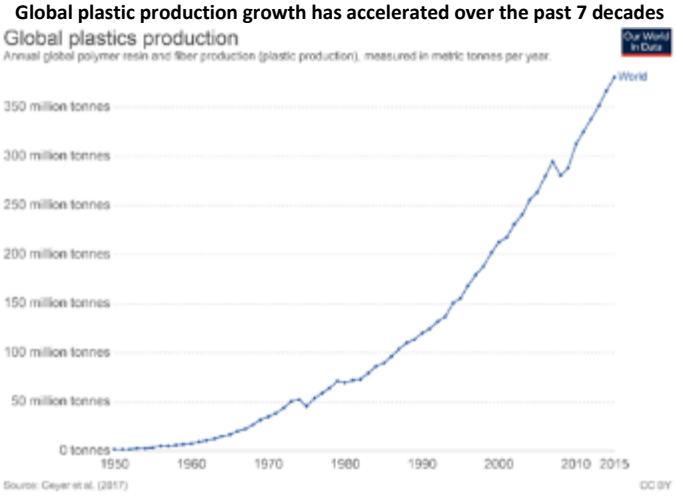
Exhibit 87: PPG is making these investments to address the problems of our day.



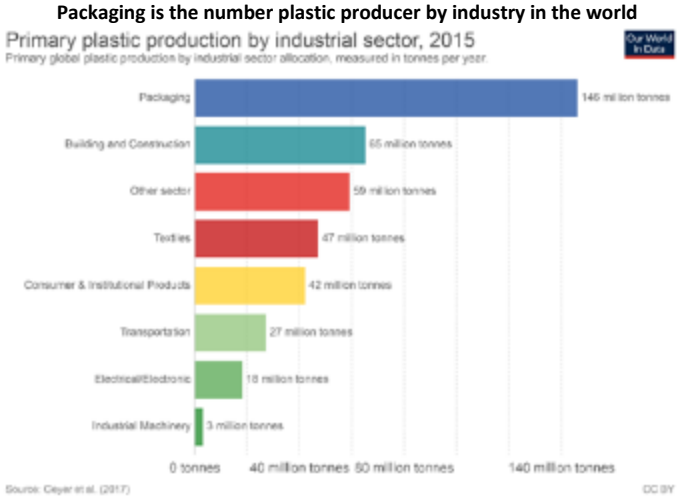
Source: PPG investor reports

Exhibit 88: A look at the evolution of annual global plastic production and plastic production by sector

Global plastic production growth has accelerated over the past 7 decades



Packaging is the number plastic producer by industry in the world



Source: Our World in Data, ScienceMag.org

Exhibit 89: Plastic entering oceans has proven to be an increasingly pervasive ecological issue

Source: National Oceanic and Atmospheric Administration, US Dept. of Commerce

Reducing waste and lowering carbon footprint – packaging solutions providers. The increasing convenience and affordability of online shopping continues to drive more consumers to buy more online. A report from eMarketer reveals that during the 2018 holiday season, e-commerce sales totaled $124B (17% y/y increase). In this rapidly changing retail environment, packaging company Sealed Air is rethinking the traditional corrugated box in efforts to reduce waste and lower freight costs. For many, items like the bulky corrugated box aren't always the best options. Often online clothing retailers have better results and lower shipping cost with polybag mailers. Further, as of June 2019, USPS (which deliverers >40% of residential e-commerce parcel shipments) has implemented "dimensional weight pricing" or dim pricing for short, which essentially charges higher shipping rates for boxes that are large and have a lot of empty space inside the box – regardless of the weight. SEE has developed a packaging solution called the polybag mailer, which has essentially zero empty space, and is a product we expect to see more of in the future.

Sustainability progresses from a special interest initiative to a mainstream lifestyle. Sustainability has been embraced by consumers, governments, manufacturers etc., all the way up the value chain. Consumers are just as interested in the packaging materials as they are in the product itself. This trend is highlighted across the globe and by observing the major beverage can producers (CCK, BLL, ARD), which are all experiencing robust metal beverage can volume growth. The beverage manufacturers themselves have also been contributing in two main ways: 1) introducing new products into cans and not plastic bottles; 2) shifting existing products out of plastics into cans. A recent example, PepsiCo has announced it is testing selling its Aquafina water in aluminum cans in efforts to eliminate thousands of tons of virgin plastic. If tests go well, we should expect peers to make similar moves in a collective effort to reduce virgin plastics. Another example of new product launches is Ball's announced plans to launch a new infinitely recyclable branded aluminum cup that will make its debut during the fall 2019 football season. This is another example of a company taking it upon themselves to innovate and introduce new products that the customer wants and serves a benefit to our planet.

Increasing uncertainty around plastic use

Growth in plastic waste has been shaping global government policy. Plastic pollution has emerged as a major concern among developed country consumers. Politicians across Europe and North America have responded by banning straws, stirrers and other single-use plastics, while China has banned all import of plastic waste. The problem is becoming even more pressing as the production of plastics is expected to boom. There are more than a dozen plants that are being built or have been proposed around the world by petrochemical companies like

Exxon Mobil and Dow, including several on the Gulf Coast. We expect the environmental concerns regarding plastic consumption to continue, leading consumers to change consumption behavior, a trend that will likely force plastic packaging businesses to reshape.

Recycling facilities have not been able to keep up. While plastic offers many benefits, including functionality, lightness, safety and versatility, much of the plastic material produced today is 'lost' to the economy after a single use (i.e. not recycled). A recently published article in the journal Science Advances estimates that of the ~6.3 billion metric tons of plastic waste produced over the past few decades, only 9% has been properly reused or recycled. While the majority of plastic products are technically recyclable, many waste management facilities have been overwhelmed. This means the majority of plastic waste is incinerated, ends up in landfills, or accumulates off in the natural environment as litter. A key issue that needs to be addressed is therefore the lack of proper recycling facilities in many large developed country cities.

Moving from a linear to 'circular economy'. It is worth noting, however, that substitutes like cotton bags, aluminum cans or paper boxes have a much higher environmental footprint, requiring more energy and water to make and transport than plastic equivalents. Therefore, despite low recycling rates, there really is not a viable alternative to plastic, and it will likely remain the most cost-effective material for disposable items. Companies will likely still be forced to adapt, and we believe the plastic packaging companies that take a longer-term view with a focus on sustainability will have a significant edge over peers. For instance, IPL Plastics integrates a circular economy mindset throughout the production process. All new products are developed with an increasing amount of recycled product or circular capabilities like take-back recycling service (see Exhibit 90).

Exhibit 90: IPL Plastics has a circular focused business model

Source: IPL Plastics Website

The global water crisis

Within the past several years, acute water shortages have struck cities like Los Angeles, São Paulo, Chennai, and Cape Town.

Global water crises are escalating as water shortages threaten over a quarter of the human population. Populations around the world are increasingly facing one of the most urgent crises gripping the planet today: water scarcity. Roughly a quarter of the Earth's population is living under extremely high water stress environments, with shortages looming across countries spanning from India to Brazil to South Africa. This dire situation has been exacerbated by climate change, which is making rainfall more erratic and the planet warmer overall, causing water to evaporate from reservoirs and threatening global water supplies. In addition, water consumption has tripled over the past fifty years, largely due to agricultural and industrial usage. This growing demand for water is pressuring countries' natural groundwater supplies and aquifers, which are beginning to run dangerously low and are not being replenished at their usual pace. According to the World Resources Institute, 17 countries across the world representing a quarter of the human population are currently living under extremely high water stress, meaning that they are on track to fully deplete their water supplies. By 2030, the number of cities facing high water stress is expected to rise to 45 from 33 today, covering nearly 470 million people and by 2030 Water Resources Group estimates that global water demand will exceed supply by ~40%.

By 2025, the number of "Day Zero" events, when cities completely deplete their water supplies, will drastically increase if municipalities do not begin investing in alternative sources of water.

Cities are urgently adopting new solutions to build secure, sustainable, and resilient water supplies and infrastructure. The good news is that there are real and effective solutions being undertaken around the world today to combat the global water deficit and build resilient water supplies. Apart from better water resource management and conservation, the two most popular and sustainable solutions to expand the world's supply of freshwater are desalination and water reuse/recycling. By 2025, we expect these two proven solutions to be increasingly adopted by cities, especially as "Day Zero" events—when cities completely deplete their water supplies—could increase in frequency over the next decade.

Water Desalination

Given that half of the world's population lives within 40 miles of the sea, we expect to see desalination increasingly embraced as a viable solution to address the water shortage epidemic.

Creating fresh water from salt water is one drought-proof solution. Desalination is the process of cleansing river water, seawater, and brackish water of salt and other potential contaminants to produce clean and potable bulk water for applications such as drinking, agriculture, commercial, and industrial usages (like mining and oil fracking applications). Historically, the most popular and rudimentary process for desalination involved vaporizing and condensing the water, stripping it of solids and salt particulates. However, over the past several decades, technological improvements in membranes, pretreatment, disinfection, and energy recovery have made desalination a more economically viable solution for purifying seawater at a larger scale. In addition, desalination has historically been popular within regions that have an abundance of salt water, but insufficient natural sources of fresh water, such as Singapore, the Middle East, and the Caribbean. As the global water shortage crisis exacerbates, we expect desalination to be increasingly adopted worldwide, even in developed markets like the US and China, especially as its cost curve becomes more favorable through technology advancements.

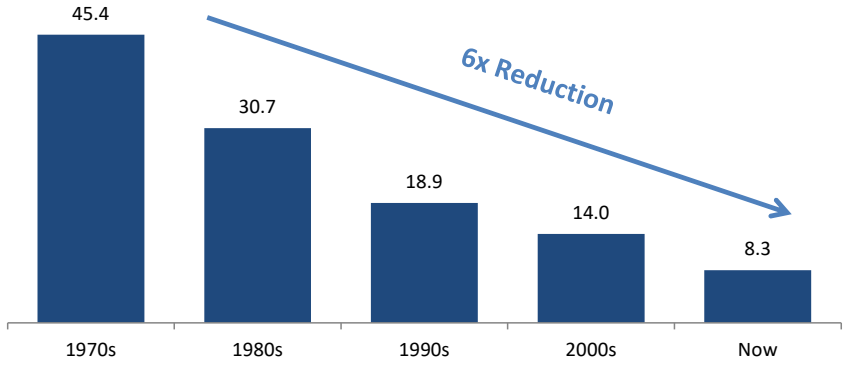
The economics of reverse osmosis desalination are becoming more favorable as membrane and pump technology and efficiency have improved, while equipment costs have declined.

Technology advances in desalination have made this drought-proof water supply more cost-effective. Historically, most desalinated water was produced through processes known as thermal distillation (such as multi-stage flash distillation, multi-effect distillation, and vapor compression). Thermal distillation is where seawater is heated and the evaporated vapor is then condensed to produce fresh water. These plants consume substantial amounts of thermal and electric energy, resulting in high levels of greenhouse gas emissions and operating costs. However, since the late 1990s, reverse osmosis (RO) has grown in popularity as an alternative desalination process. RO is a form of pressurized filtration in which the filter is a semi-permeable membrane that allows water, but not salt, to pass through, resulting in clean, sometimes potable water. RO technology has improved considerably in the past few decades,

and modern-day plants can desalinate seawater with much less energy usage than thermal distillation. Specifically, Global Water Intelligence estimates that desalination energy costs have declined by 6x over the past four decades, as shown in Exhibit 91.

The cost of desalination has declined by 6x over the past four decades, driven by improved membrane and pump technology efficiency and declining equipment costs.

Exhibit 91: Improvement in Desalination Energy Use per Kgal of Water (kHw)



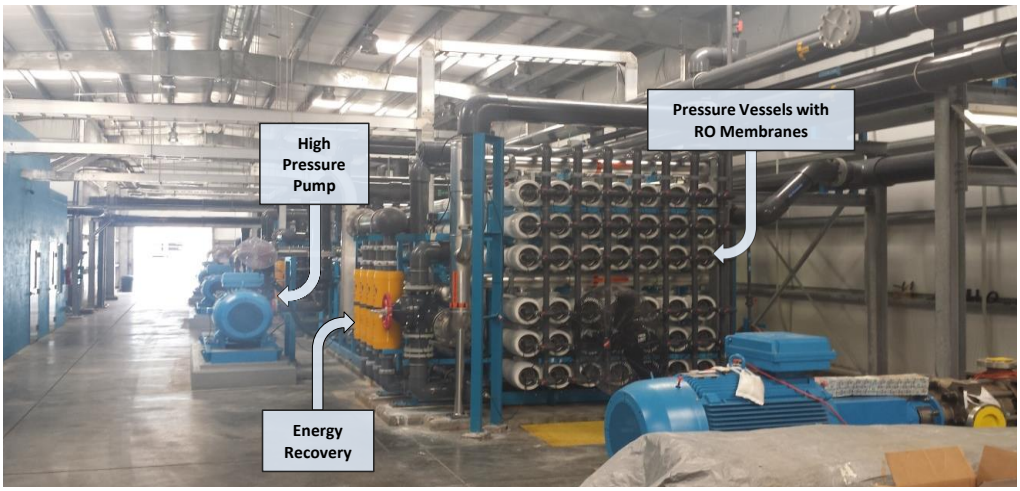
Source: Global Water Intelligence, Company reports

Key technological improvements within RO desalination. Advances in the energy efficiency and cost-effectiveness of seawater reverse osmosis have been made possible by an array of improvements to the membrane filter, more efficient pumps, energy recovery devices, and control systems, as well as overall lower equipment costs. While it is not intended to be a comprehensive technology discussion on RO technologies, the following section highlights some of the key improvements over the past ten years that have enabled RO desalination to be more widely adopted as the only "drought-proof" solution for water-stressed coastal regions. RO has always been an energy-intensive process, but this cost input has been greatly reduced over the decades by the following advancements:

- **Membrane technology.** In general, advances in material science have made membranes more efficient, allowing the filtration systems to operate at a lower pressure (thereby reducing the electricity usage for the pumps). Some of these advances involve the uniformity and precision manufacturing of the pores in the membrane itself. RO pore sizes can range from 0.0001um to 0.001um, which is the finest separation material currently available to the industry. Some advances in material science have made the membrane substrate more robust, less susceptible to fowling, and more resistant to damage from cleaning. The sequencing of using nanofiltration for pre-treatment of the seawater has also become more precise. Leaders in RO membrane technology include Dow FilmTec, Toray, Evoqua, and Suez (previously GE Osmonics). In addition, the earlier pretreatment stage of an RO process typically employs nanofiltration technology, where Danaher's Pall and Pentair's NORIT are among the leaders.
- **Pump efficiency.** Advances in pump technologies over the last ten years include optimizing impeller designs, stronger/lighter materials, variable speed pumps, remote diagnostics, and other "smart" technologies. Among the key players in this highly fragmented industry are Xylem, Pentair, Flowserve, Sulzer, and Grundfos.
- **Energy recovery devices.** Over the past decade, there has been a broad adoption of energy recovery systems that are integrated into an RO system. Energy Recovery Inc. is the market leader in this field and among the first to popularize this technology. In simple terms, when seawater is being pressured into the membranes at 900-1,000 PSI, the now-outdated practice was to simply allow that pressure to dissipate through a pressure relief valve. The introduction of energy recovery systems allows the system to recapture that high pressure using a Peloton-wheel turbine and transmit the energy back to the pump stage, in a process analogous to a turbo charger. Energy recovery systems are estimated to recover 20%-40% of the total energy use.

- **Controls.** In-line sensors allow for real-time control and optimization of the RO process, such as by measuring the salinity levels and testing the produced water.
- **Lower cost of equipment.** Some of the technological advances, commodities deflation, and global competition have resulted in lower cost of equipment.

Exhibit 92: Key Components of a Modular Desalination System



Source: RBC Capital Markets

Today, Seven Seas' facilities represent 20% of the desalination capacity in the Caribbean and are present on nine different islands.

Case study: AquaVenture Holdings (ticker: WAAS). AquaVenture operates a business named Seven Seas Water, which is a leading provider of outsourced desalination, water reuse, and wastewater treatment services. Specifically, the company enters into long-term agreements to sell reliable and cost-effective fresh water for customers operating in water-stressed coastal regions, such as the Caribbean. This is accomplished using containerized seawater reverse osmosis (SWRO) treatment systems designed to Seven Seas' precise repeatable specifications. Among its facilities is a location on St. Thomas in the U.S. Virgin Islands, which illustrates the advantages of its modular, containerized desal units and their ability to be quickly deployed in response to emergency water crises. In 2011, the island's aging thermal desalination plant was failing to keep up with local water demand and crippled by significant downtime, causing an emergency water shortage that threatened over 5,500 residents, local businesses, and several hundred thousand tourists. In response, the USVI Water & Power Authority (VIWAPA) called on Seven Seas to supply 2 million gallons per day (MGD) of emergency water as quickly as possible. Within 29 days of the contract signing, three containerized Seven Seas RO units were installed and operational at the plant site, producing 0.75 MGD of emergency water. Just 17 days later, five more units were operational, and the combined desal system was able to supply the entire requested capacity and refill VIWAPA's nearly depleted water storage tanks. While these temporary units operated on the side, Seven Seas began work on constructing a permanent SWRO facility on the island, which was officially commissioned by the VIWAPA in 2013. The current St. Thomas plant has a capacity of 3.3 MGD and services the VIWAPA as its exclusive water supplier.

Water Reuse

Water reuse can help replenish potable water supplies and combat water scarcity. Water reuse (also known as water reclamation or recycled water) is the process of converting wastewater back into potable water that can be used for agriculture, environmental and aquifer restoration, commercial and industrial applications, or even drinking. The water treatment technologies used for water reuse are myriad and typically include a combination of ultrafiltration, aerobic treatment, reverse osmosis, ultraviolet disinfection, and advanced oxidation, among other treatment steps. The water is treated and refined until it can meet

stringent quality standards and is deemed hygienically safe and free of bacteria and other contaminants. For now, most of the recycled water globally is being used for irrigation and commercial applications, but there are some technologically sophisticated cities that have seamlessly integrated water reuse into their drinking water supplies, such as Singapore (see the case study at the end of this section).

There are roughly 700 water reuse projects being planned across California, versus only a handful of desalination projects nationally, highlighting the disparity in adoption between the two water solutions within the US.

Water reuse is growing faster in the US than water desalination due to regulations and economics. Within the US, adoption of water reuse and reclamation is actually growing faster than desalination. This is partly due to the strict regulatory environment in the US (especially around environmental concerns), which limits the locations where new large-scale desalination plants can be installed. In contrast, regions like the Middle East have less onerous regulations in place, allowing for faster adoption of desalination. Another major driver of water reuse's growth is its improved economics, as recycled water is roughly half as costly to produce as desalinated water. For instance, in regions like California, desalination requires the installation of a subterranean intake system, which significantly multiplies the cost of the project versus a water reuse system. In our view, water reuse has already reached the tipping point in terms of technological advancements and has proven itself to be an effective and safe solution for expanding a municipality's water supply.

- **Water reuse remains stigmatized in the West due to media sensationalism.** Despite the attractive economics and proven technologies, the biggest hurdle against water reuse reaching mass adoption in the US as a source of potable water remains public opinion and acceptance. Part of this is attributable to how the media tends to disingenuously sensationalize or mischaracterize the risks of water reuse. Until water reuse is able to shed the stigma of "toilet to tap" and shift public opinion, it will likely not be able to reach its full potential as a reliable source of potable water in the US, unlike in more advanced cities like Singapore. We expect that water reuse will be mostly limited to agricultural and industrial/commercial applications in the US for the time being. That said, indirect potable reuse—whereby the recycled water is injected into the environment or natural bodies of water, rather than directly into a municipality's drinking water supply—has been received more openly by the US population.

Case study: Singapore is the "gold standard" of cities adopting advanced water treatment technologies. Given that the island city-state has no natural sources of freshwater, Singapore has invested strategically on innovative high-end water technologies for desalination and water reclamation/reuse. For decades, Singapore has piped in potable water from nearby Malaysia. That contract is scheduled to expire in 2061, and Singapore aims to become sustainably self-sufficient in its water supply before then. Understandably, for Singapore, combating water scarcity is seen as a national security issue. As a result, the country has arguably become the international "gold standard" for embracing cutting-edge water technologies. Its national water agency, the Singapore Public Utilities Board (PUB), is renowned across the world for collaborating with over 170 businesses, academic institutions (like MIT), and government agencies to advance and share the latest innovations in water. The upshot is that Singapore has become a "test bed" for piloting new water solutions, such as its adoption of ceramic membranes, Xylem's Visenti non-revenue water monitoring capabilities, or biogas as a source of energy for its water reclamation plants. Currently, Singapore consumes roughly 430 million gallons of water per day, with the demand split between 45% from homes and 55% from the non-domestic sector. By 2060, Singapore projects that its total national water consumption could nearly double, driven by growth in the non-domestic sector, which is expected to account for 70% of future demand. To address the country's water needs, the PUB has embarked on a massive capital investment program to improve its water management and expand the sources of its water supply. The key prongs of its water management strategy include:

- **NEWater (i.e. reclaimed water).** Singapore's so-called "NEWater" is a high-grade reclaimed/recycled water supply produced from treating used water with advanced membrane technologies and ultraviolet disinfection. The water is ultra-clean and safe to drink and advances the country further towards water sustainability and self-sufficiency. Today, Singapore operates five NEWater reclamation plants, which supply 40% of the country's water needs. By 2060, NEWater is expected to meet up to 55% of Singapore's total water demand. We highlight that Singapore is far ahead of any other country in embracing water reuse/reclamation. At this time, only ~5% of its central drinking water supply is sourced from NEWater, but this percentage is expected to be progressively increased over the coming years.
- **Deep Tunnel Sewerage System (DTSS).** Described as "the wastewater superhighway", Singapore's DTSS is a 48 kilometer-long system of tunnels that transport used water to reclamation plants to be treated/purified into NEWater or discharged into the sea. Phase 1 of the construction of the DTSS was completed in 2008 at a cost of $3.4 billion SGD ($2.5 billion USD). Phase 2 is targeted for completion in 2022 and will cover the western and southern parts of Singapore.
- **Desalination.** As an island city-state, Singapore has invested heavily on developing desalination capabilities to convert its widely-accessible sources of seawater into potable water. Today, the country employs three desalination plants (Tuaspring, SingSpring, and Tuas desal plant #3) that can meet up to 30% of the country's current water demand with a combined capacity of 130 million gallons per day. Furthermore, two additional plants are expected to be operational by 2020. By 2026, the PUB expects desalinated water to meet up to 30% of Singapore's future water needs.
- **Minimizing "non-revenue" water.** Today, a global-best 5% of Singapore's total water production is classified as "non-revenue water" (e.g. leaks, theft, and inaccurate water metering). This represents one of the lowest ratios in the world, and compares favorably to the ~25%-35% average of other developed markets. Part of Singapore's ability to minimize non-revenue water is its adoption of high-end water analytics, metering, and in-pipe diagnostics, such as those supplied by Xylem's Visenti and Pure Technologies.

Exhibit 93: Singapore's Tuas Desalination Plant No. 3

Source: Singapore Public Utilities Board

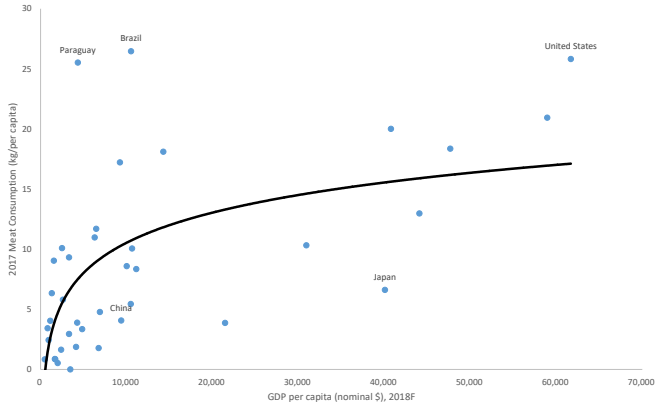
The answer to rising food requirements? Smart-farming

Recent UN estimates indicate one in nine people experienced chronic hunger in 2018 with the total global population continuing to grow. To help meet rising food requirements amidst limited natural resources (arable land, water), we anticipate continued adoption of smart farming while the scientific community will be further incentivized to drive advances in

bioengineering. We expect increased comfort toward bioengineered food as benefits are better understood/concerns abate, with potential for genetically modified crops to augment better farm practices (more efficient planting, watering, harvesting) and yield.

Further, a growing middle class in places like China and India is expected to lead to increased protein consumption as people tend to eat less starchy food as income rises. This trend will drive need for more livestock and feedstock for the animals. Separately, increased urbanization trends indicate more concentrated demand areas in the future. In 2009, FAO estimated that livestock accounted for 70% of global agricultural land and also expects global meat production to be 16% higher in 2025 from the 2013-2015 base period, with poultry the largest driver.

Exhibit 94: Meat consumption vs. GDP per capita



Source: OECD, IMF

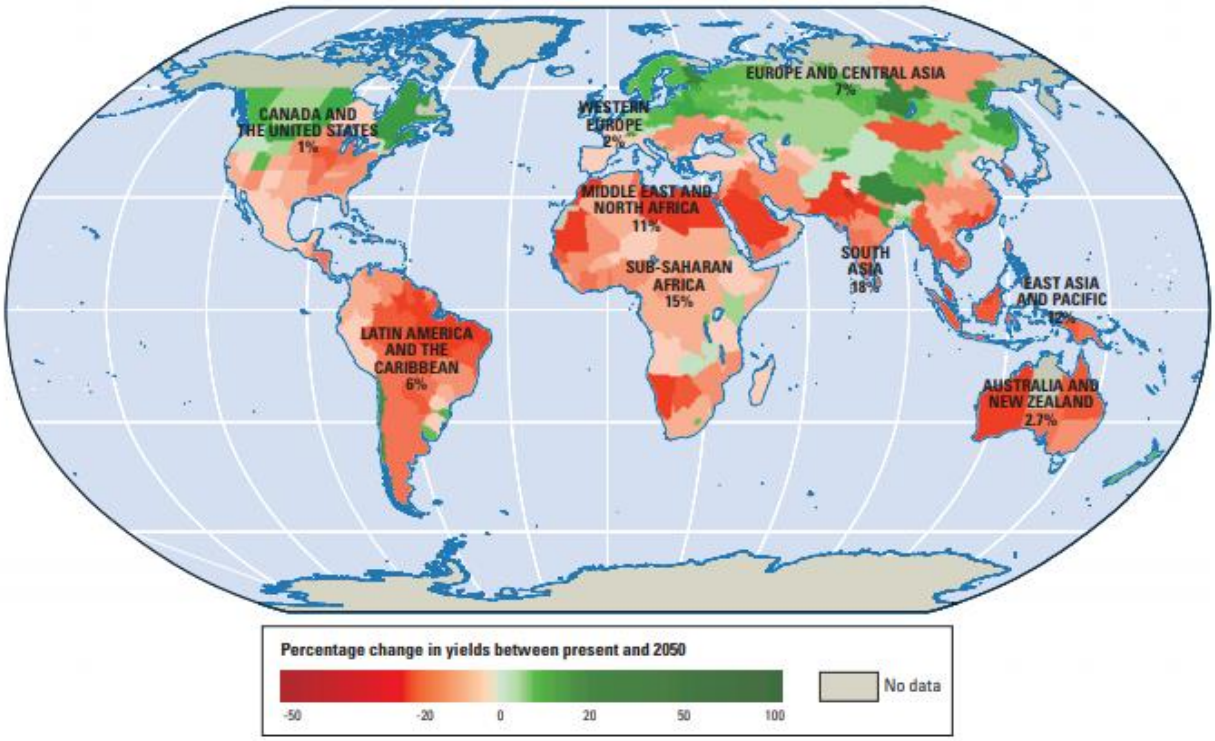
Exhibit 95: Expected Growth in Protein Demand

Source: AGCO 2015 Analyst Day Presentation, USDA, World Bank, WSJ

Global warming and climate change pose some of the greatest threats to the global food supply outside of continuously increasing demand due to population growth. Per a 2010 World Bank report, climate change is expected to reduce agricultural output across most countries by 2050 with the most severe impact in developing nations (75-80% of total) given their dependence on ecosystem services and natural capital for production in climate-sensitive sectors. As discussed above, bioengineering can help combat global warming by pushing along evolution and having plants utilize C4 photosynthesis instead of C3, which has been proven to increase yields at higher temperatures.

A growing population will also result in increased carbon emissions. California's Salk Institute for Biological Studies' Ideal Plant initiative is trying to engineer plants that have the ability to store more carbon dioxide in their roots; the expectation is that if it is done across a large scale with major agriculture crops, it would remove carbon emissions and therefore slow down climate change. Additionally, the institute believes that a plant with increased suberin and the ability to hold onto more carbon would be more drought and flood resistant.

Exhibit 96: World Bank Group Climate Change Ag Yield Impact Forecast



Sources: Müller and others 2009; World Bank 2008c.

Note: The coloring in the figure shows the projected percentage change in yields of 11 major crops (wheat, rice, maize, millet, field pea, sugar beet, sweet potato, soybean, groundnut, sunflower, and rapeseed) from 2046 to 2055, compared with 1996–2005. The yield-change values are the mean of three emission scenarios across five global climate models, assuming no CO_2 fertilization (a possible boost to plant growth and water-use efficiency from higher ambient CO_2 concentrations). The numbers indicate the share of GDP derived from agriculture in each region. (The share for Sub-Saharan Africa is 23 percent if South Africa is excluded.) Large negative yield impacts are projected in many areas that are highly dependent on agriculture.

Source: The World Bank

Who is best (worst) positioned?

We believe established OEMs like Deere and AGCO are well-positioned in the smart farming evolution given their dominance in major markets, extensive dealer networks, and continued commitment to developing (internally and via acquisition/partnership) precision ag/smart farming technologies. We believe Deere has an edge in North America, given its stronger presence in HHP equipment and dealer network.

We do not see risk of cannibalization for the OEMs in this industry because the likelihood of new companies trying to manufacture highly specified machines seems low especially with the major players having an unrivaled advantage with their extensive dealer networks and providing essential service and support.

The ultimate "loser" in an evolving industry toward big data/precision planting/greater efficiency could be input suppliers such as fertilizer, seed, and other chemical providers where they would lose business as a result of more efficient application of product and waste

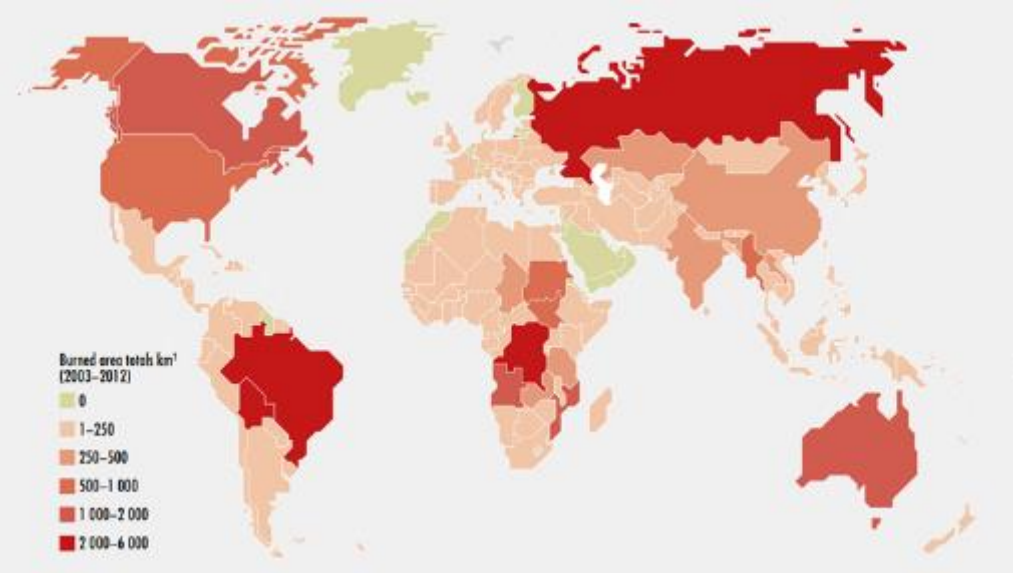
minimization from precision ag techniques. Some studies suggest a 20-40% savings in the amount of water and fertilizer used on farms with precision agriculture (The Nature Conservancy). Meanwhile, the aforementioned Blue River claims its devices are able to reduce the amount of chemicals farmers use by up to 90% by distinguishing weeds from plants based on size, color, shape and applying pesticides/herbicide in only the exact places they are needed. As a result, the standard practice of spraying an entire field indiscriminately in the event of pest/weed problems could change.

I've seen fire and I've seen rain, but not quite this bad

The increasing frequency of extreme weather events is negatively affecting timber supply and demand globally. In the Canadian province of British Columbia, the 2018 wildfire season set records for total area burned, and was attributed to record-breaking temperatures and severe lightning storms. In total, the cost of fighting the fires cost C$615 million. The 2018 season followed another record-breaking fire season in 2017, which cost the province C$649MM to fight. In 2018, record-setting fires were also recorded in California. We expect the frequency and severity of fires to increase with the warmer temperatures experienced globally.

Forest fires result in the destruction of timber assets, production downtime at nearby facilities, and potentially total destruction of production assets. In terms of longer-term implications, the 2018 fires in BC damaged Norbord's ability to secure sufficient wood supply, contributing to the mill's permanent curtailment in 2019. The significant wildfire activity during the year also contributed to the significant run up in prices in 2018, as supplies could temporarily not be secured to meet demand in other parts of North America. We envision additional wildfire activity contributing to increased volatility in the sector.

Exhibit 97: Total forest area burned by country (2003 to 2012)

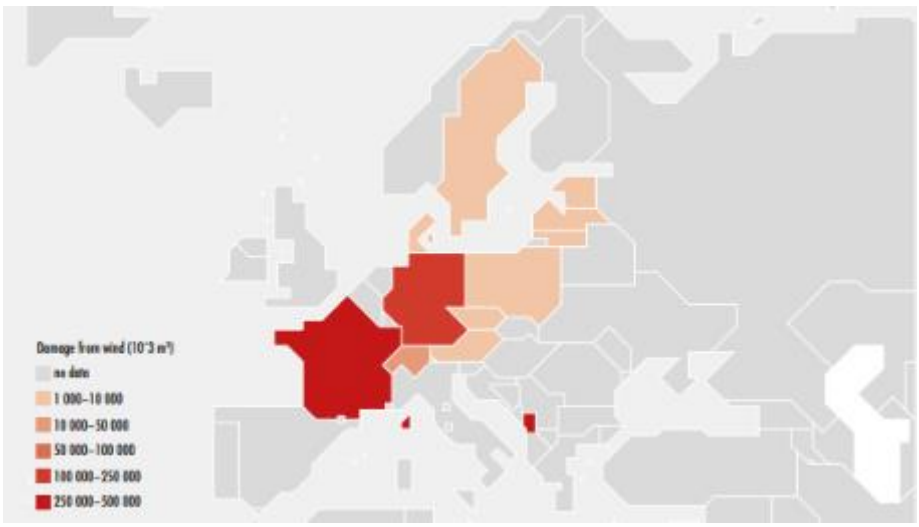


Source: FAO (based on data from the University of Maryland)

In Europe, wind and beetle damage has caused a significant rise in local fiber supply. This has had a number of impacts on the global forest product industry. Firstly, it has resulted in lower lumber costs in Europe, as companies are legally required to harvest the damaged wood, resulting in an increased supply to market. Secondly, the increase in harvestable fiber has resulted in lower wood chip costs for companies such as Mercer International. We believe that this has allowed European pulp companies to produce at an economic level despite the currently low pulp prices globally and weaker domestic demand conditions. Finally, much of

the excess timber supply is being shipped via railroad to China. This increase in supply to China is having a negative impact on New Zealand export timber prices for companies such as Rayonier Inc. When the wind blows in Europe, it is truly felt around the world.

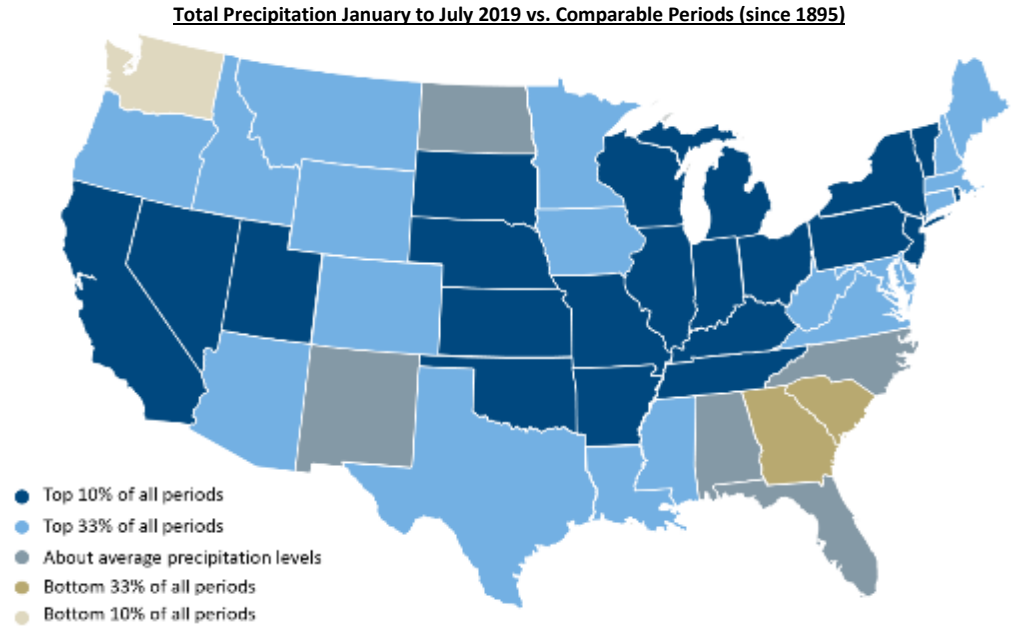
Exhibit 98: Wind damage in Europe has increased fiber supply



Source: FAO

The past year has also been one of the wettest ever experienced in the continental United States. The wet weather has negatively impacted the North American forest product sector in a number of ways. Firstly, it has significantly reduced demand for building products, since construction activity cannot procced as quickly in wet weather. Secondly, it has resulted in much more challenging conditions for logging companies, since the wet and muddy conditions do not allow their equipment to operate effectively. This has reduced timber supply for local lumber companies and fiber supply for pulp companies. On the company's Q1 2019 conference call, Rayonier Advanced Materials noted that the higher hardwood costs significantly affected the company's profitability during the quarter.

Exhibit 99: The US has experienced extremely wet weather YTD in 2019



Source: NOAA, RBC Capital Markets

Potential uncertainties in the railroad industry

Increasing incidents of extreme weather may impact operations at the railroads. As the planet warms reflecting increased concentration of greenhouses gases, land use changes, etc. we have seen an increasing number of extreme weather events. This past winter we experienced the polar vortex and this past spring saw historic flooding along the Mississippi. The railroads encountered significant operational issues from these events with the Canadian rails running much shorter trains during the extreme cold due to air brake limitations and UNP diverting significant traffic in the Midwest resulting from the flooding along the Mississippi. Scientists expect these types of extreme weather events to become more common as the planet warms, and, as such, we would expect this to negatively affect the railroad industry. We do think that the railroads will be able to adapt to a certain extent but the sporadic nature of these events make planning difficult and their impact more severe.

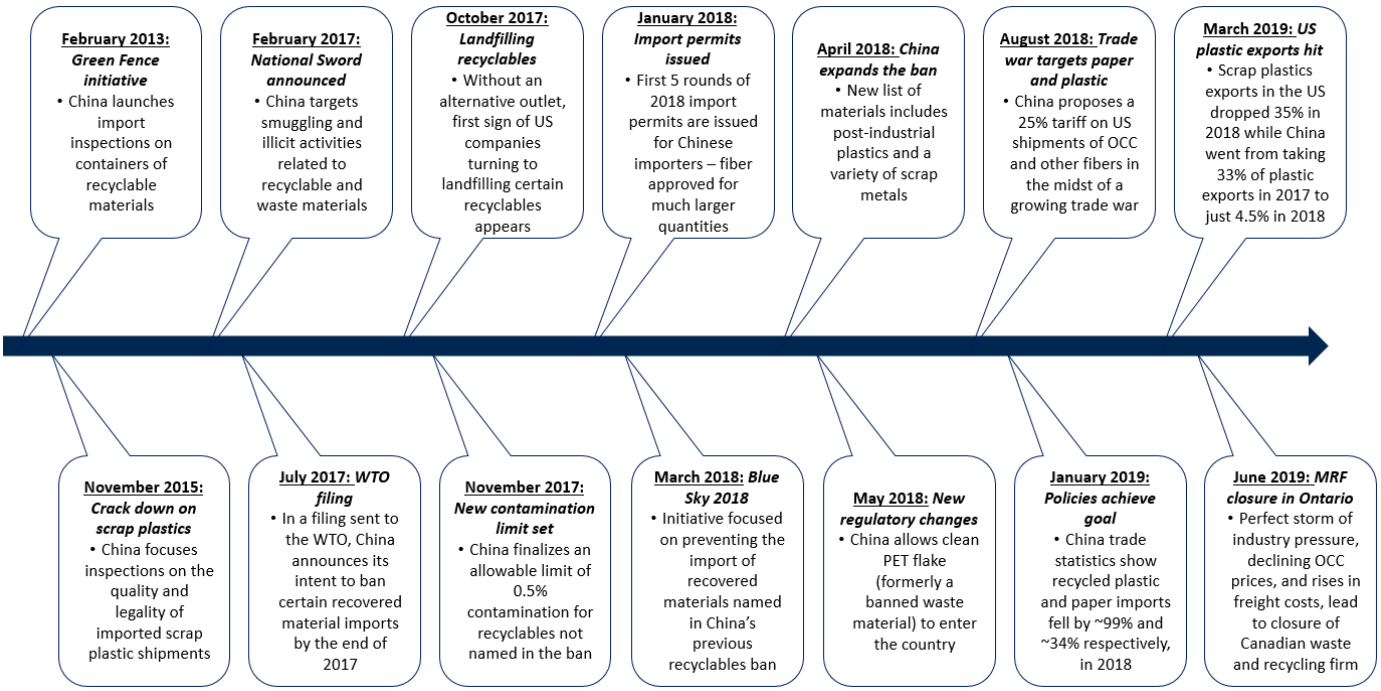
Coal headwinds are likely to affect volumes on the railroads. Coal represented ~27% of US electrical generation in 2018 as per the US Energy Information Administration and our view is that this percentage is likely to decline. We continue to see headwinds to US domestic coal usage reflecting low natural gas prices as well as the more efficient renewable sources. We note that coal represents between 15-18% of 2018 revenues at the US rails and between 5-9% at the Canadian rails. As such, the impact to the railroads could be significant. However, we believe that the railroads are anticipating the long-term decline of coal and we expect them to mitigate lost revenue through higher prices as well as increased volumes from other sources (i.e. truck to rail conversions).

How China has revolutionized the recycling industry

In 2013, China launched its "Green Fence" initiative – a program aimed at increasing the level of inspection associated with imports of recyclable materials. In the years following that announcement, China then announced its National Sword campaign in February 2017 – an initiative targeted at curbing criminal activity related to the processing, handling, and importing of recyclable materials. Since then, the country has implemented a comprehensive set of rules and regulations governing the acceptance of paper, plastics, and other recyclable materials into their country. The most restrictive of these regulations was initiated in a July 2017 WTO filing banning dozens of scrap papers, plastics, and metals (and upending recycling economics around the world in the process). We present a more detailed outline of key events in the China import saga and their respective impacts on NA recycling in Exhibit 100 below.

As global supply chains become further intertwined and government fiscal policies continue to have increasingly more pronounced global ramifications/ripple effects, we view China's contamination restrictions (and the subsequent series of events that followed) as a prime example of the impact a decision with an uncertain final outcome can have on a global industry. While the aftermath has yet to reach a complete resolution, it is safe to say that policy measures taken by China and other Asian countries have materially altered the business models of companies operating in the recycling industry. In turn, large public companies have acted quickly to offset headwinds (namely a precipitous drop in recycled commodity prices) created by these restrictions, and in doing so, have passed on the majority of this pain to customers. Although the China contamination/import restriction saga and its impact on the recycling industry represents just one very specific example of an "escalating uncertainty", we think the broader ripple effects caused by this dynamic (ie. costs being passed-through to customers and business models being restructured) can provide a helpful read-through should a similar situation occur elsewhere in the future.

Exhibit 100: Key milestones in the ongoing Chinese import restrictions saga and related impacts on the NA recycling industry

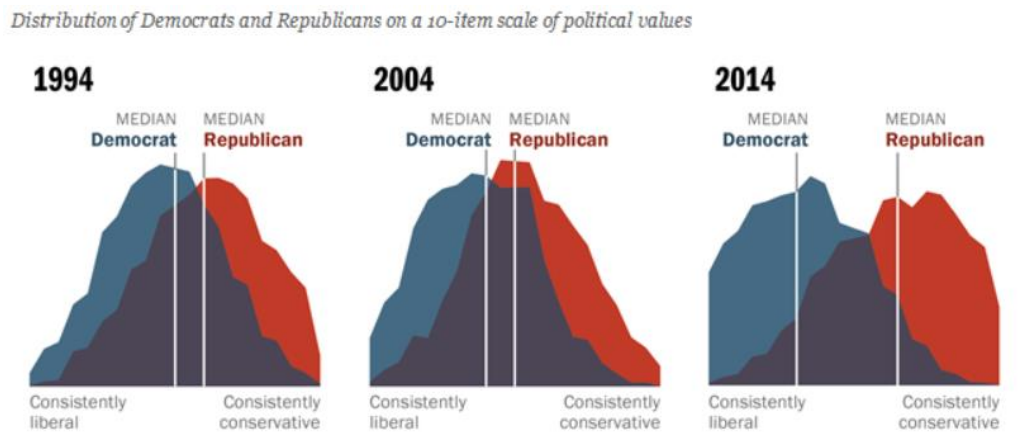


Source: RBC Capital Markets, Resource Recycling

Regulatory uncertainty and potential implications for labor laws

In an increasingly polarized political environment, policy ideas and proposals from the far ends of the political spectrum contribute to uncertainty as to how labor and employment laws could evolve over time to either the benefit or detriment to staffing companies and employers who utilize temporary labor. The debates contribute to heightened uncertainty and may lead employers (including users of temporary labor) to change how they manage their workforce.

Exhibit 101: Democrats and Republicans more ideologically divided



Source: Pew Research Center (2014 Political Polarization in the American Public)

A risk: stricter temporary labor laws (or even simply public/political pressure)

The rising popularity of far left progressives has given greater voice to several proposed labor reforms. Potential for more restrictive legislation of temporary workers (e.g. length of worker assignments, pay/benefit structures) could cause significant disruption to staffing companies.

As an example, 10 U.S. senators recently called on Google to take "immediate action" on what they believe are misuses of independent contractor and temporary worker classifications where its temporary workforce outnumbers its full time workers. The senators urge a number of policy changes, including: automatic conversion of temporary workers into full time roles after six months, prohibition of financial disincentives (e.g., fees to staffing companies for converting a temp into a permanent role), wage and benefit parity regardless of worker classification, and limitations on the type of work temporary workers are allowed to perform. Importantly, the group of senators include Elizabeth Warren and Bernie Sanders – who have been vocal about their progressive agendas, including issues related to worker protections and income inequality issues broadly.

An opportunity: minimum wage increases

At the same time, an increase in the federal minimum wage would also have implications on the labor market, potentially serving as a tailwind for staffing companies as bill rates tend to expand alongside wage inflation.

Theme VI: The Agility Imperative

The Agility Imperative is based on the increasing need for industrial companies to be flexible and able to quickly adapt to competitive, economic, technological, political, and societal change forces. Incumbency and existing brand equity will no longer be enough to carry companies through changing times, and/or guarantee market position and relevance. In fact, complacency in some cases could even lead to a company's demise; companies will have to change their structures and culture to adapt.

What you need to know

No company, regardless of size, is immune from disruption. The longer a company defers tough decisions (which could impact near-term financial performance), the less relevant these companies could become to their customers, employees, and investors over time. As it currently stands, the current environment is prime for disruption. From a platform and infrastructure standpoint, advancements in technology such as additive manufacturing and 3-D printing have lowered the complexity of manufacturing processes and allowed companies to provide products/equipment at a scale otherwise unattainable. This, in turn, has spurred a wave of consolidation in the industrials space where firms now look to employ M&A as a means to replace R&D spending. As a result, the threat of disruption is as prevalent as it ever was, and companies may be forced to disrupt themselves or become disrupted.

We believe Siemens Chairman, Jim Hagemann Snabe, described this theme well in May 2019 when he highlighted the requirement to constantly reinvent the portfolio. While in the first three industrial revolutions scale was key, he now saw it as more about being able to move at speed. He highlighted that traditional conglomerate structures are disadvantaged in this respect as they cannot move fast enough, although he does not view dismantling conglomerates as always being the best course of action. If it possible to combine market focus and speed of innovation while being part of a group, he sees advantages especially in a time when platforms have an advantage.

The four agility mandates:

Make people believe. The brain drain towards the best companies is accelerating as the global labor force is increasingly open to all. This underscores the need to create compelling and inspiring work cultures and incentives as the competition for talent (particularly the younger generations) intensifies.

Consider a new business model. The right business model can create a path to success and also facilitate agility. At times, the best future business model may require investment (e.g., a near-term EPS sacrifice) or otherwise seem like a risky option. M&A can also be used to provide enhanced capabilities or transform business models that were either unfeasible or uneconomical to develop through organic initiatives.

Partner where possible. Similar to as we discussed in "Collective Action", the broader technology landscape is fraught with "frenemy" relationships. High profile examples of this include Uber/Daimler, Lyft/GM, and Google/FCA. The ability to effectively navigate through these dynamics will be instrumental to a company's success in the long run.

Lighten up. Ownership of physical assets has become less important and we believe this trend will continue. Asset-lite models thrive in the ever-increasing digital world and the shared and gig economies. Our increasingly interconnected world puts more value on capital asset-lite networks (i.e., gig economy companies) vs. weighty assets. 3-D printing and additive manufacturing are key examples.

Companies Highlighted: Randstad, ManpowerGroup, Robert Half International, ASGN, Adecco Group, Roper, Flowserve, Evoqua Water Technologies, GE, Ford, BMW, Lowe's, Honeywell, Garrett Motion, Xylem, Bodycote, Oerlikon, Hexagon, Waste Management, GM, Google (Waymo), Tesla, Volkswagen, Domino's Pizza, Walmart, Lyft, Uber, Daimler, Lear Corporation, Borgwarner, Dana Group, Adient, Aptiv, BMC Stock Holdings, Builders FirstSource, Skyline Champion Corporation, Louisiana-Pacific Corporation, KB Home, Toll Brothers, Owens Corning, Masco Corporation, Masonite International, Fortune Brands Home & Security, JELD-WEN Holding, Mohawk Industries, Whirlpool Corporation

Getting creative with the competition for talent

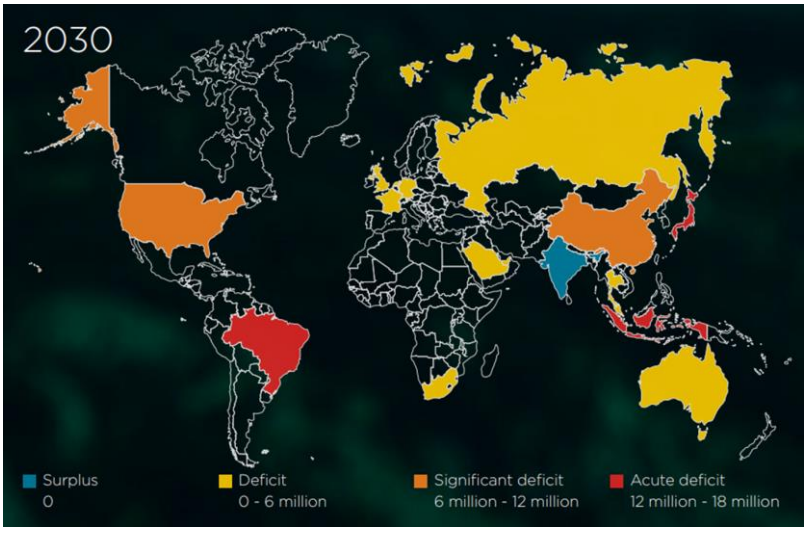
Traditional staffing companies will need to become more nimble to adapt to societal change forces and a shifting workforce eco-system. Increasing use of digital platforms/solutions and other technology pose a potential disintermediation threat to traditional players, with long-term success in part determined by willingness to embrace new technology and alternative/complementary business models. With benefits of scale and healthy balance sheet/cash flows, large staffing incumbents are well situated to make investments to defend their market position in a category rife with innovation and newer entrants.

Staffing companies have focused investment in talent acquisition and engagement, including efforts to leverage digital innovation and AI to more efficiently source, target and engage with candidates, assess skills and fit, and conduct interviews remotely. Given the fact that the supply of qualified labor is the core staffing service offering, we expect continued emphasis on talent acquisition, including internal investments, partnerships with established third parties with in-house data science/AI expertise (e.g. Google Cloud Talent Solutions API), and strategic M&A. However, this must be combined with a broader "future of work" strategy.

To that end, it will become increasingly important for staffing companies to position their businesses to evolve in anticipation of labor market disruption at the hands of (among other things) more automation. As an example, a number of staffing companies have increased focus on growing "statement of work" offerings, undertaking responsibility for project milestones and deadlines for the client, and leveraging professional/specialty labor. We expect a shift toward these higher value/project-based solutions (vs. transactional client/candidate matching to fill a position) and more specialty/professional verticals (vs. at-risk/commoditized verticals like clerical/light industrial) to continue – which we note is critical for staffing companies to remain competitive.

Staffers also need to compete for skilled workers and to reskill/upskill underqualified talent, particularly as the skill gap/talent shortage intensifies. A 2018 Korn Ferry report estimates a talent shortage of 85.2 million people globally by 2030 as demand for skilled workers outstrips supply. Even with advancements in AI and machine learning, technology can't find talent when it does not exist. Staffing companies that invest in associate skill development/mid-career training will be best-positioned, in our view, to help meet labor needs.

Exhibit 102: Talent deficit by economy



Source: Korn Ferry (The Global Talent Crunch, 2018)

What are staffing companies saying and doing?

Randstad 2018 annual report: *"We will also continue to focus on expanding our proven strong concepts, particularly In-house Services, Professionals, RPO and MSP. In particular, we aim to accelerate the growth of our offerings in Statement of Work (SOW) and outplacement. The SOW market offers a lot of growth potential for Randstad's Professionals business, mainly in the IT and engineering space."*

Randstad was among the first of the large staffing companies to prioritize innovation in the staffing/employment services space. In 2014, it launched the Randstad Innovation Fund (RIF), to explore investments in areas such as social sourcing, online platforms, mobile solutions, gamification and big data analytics. RIF fits within Randstad's broader "Tech & Touch" strategy introduced in 2016 that underscores its focus on a tech and data-driven foundation. In assessing Randstad's moves, there is clear emphasis on innovation in talent sourcing and engagement, evidenced by the launch of its Video & Digital Assessment (VIDA) solution (facilitates flexible and remote interaction between clients/candidates), its WorkForce Scheduling (WFS) platform (a mobile app enabling real-time staffing decisions/planning between clients/candidates), outright acquisitions, various chatbot pilots, among others.

Exhibit 103: RIF investments

Date	RIF Investments	Category
Mar-2014	Gigwalk	Freelancer management system
Jul-2014	Twago*	Online staffing platform
Sep-2014	rolePoint**	Employee referrals
Nov-2014	Vonq	Online recruitment services
Jun-2015	Brazen	Candidate engagement platform
Jul-2015	Checkster	Credentialing platform
Jan-2016	Crunchr	Workforce analytics
Feb-2016	Pymetrics	Gamified psychometrics
Dec-2016	Wade & Wendy	Recruitment chatbot
May-2017	Cornerjob	Mobile job matching
Oct-2017	Montage	Candidate engagement platform
Feb-2018	HackerRank	Recruitment platform/Code challenge community
Feb-2018	Gr8 people	RPO
Mar-2018	Allyo	Recruitment chatbot
Jul-2018	Goodwall	Mobile professional development
Jul-2019	Validated ID	Payrolling, compliance

*Acquired by Randstad; **Exited
Source: Staffing Industry Analysts (Investing in the Workforce Solutions Ecosystem, May 2019), Randstad reports, Crunchbase, RBC Capital Markets

Manpower CEO 2018 letter to shareholders: *"We are investing in data-driven insights, assets and assessments that predict people's performance, help people understand their potential and better predict workforce needs. In 2018 we appointed our new Chief Talent Scientist to lead ManpowerGroup's global Assessment Center of Excellence and are investing in B2B and B2B+B2C tech-enabled solutions. We are accelerating our implementation of world-class front-office systems, cloud-based and mobile applications and other enhancements to our global technology infrastructure, digitalizing our workforce solutions offerings to lower transaction costs."*

Manpower has been investing in cloud and mobile-based application implementation, as well as tech-enabled solutions incorporating AI. For example, it introduced an AI-powered interviewing chatbot avatar "Zara" which conducts and analyzes a video interview before generating a report with recommendations to recruiters. In addition, it launched IntelliReach within its MSP business that offers clients transparent analytics and comparative benchmarks

to execute an effective workforce strategy. Lastly, it is also investing in upskilling/reskilling its workforce, with its MyPath program that gives it associates access to accelerated learning programs, on the job training, certification, and experience.

Exhibit 104: Manpower's digital assessment room

Source: Manpower

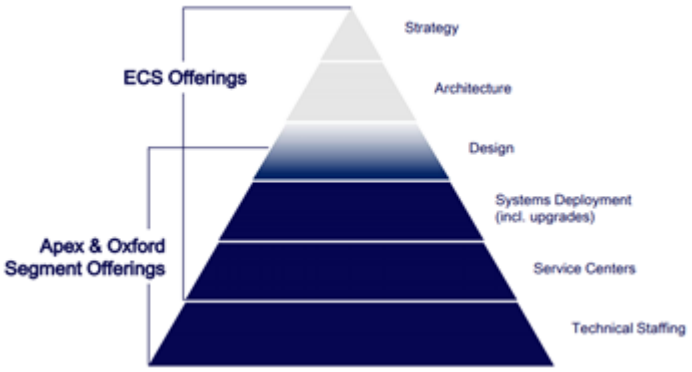
Robert Half 2018 annual report: *"Our expanded suite of consulting offerings includes risk and compliance, data and analytics, and performance improvement, among others. Protiviti is putting more focus on technology consulting, with an additional emphasis on cybersecurity, cloud computing, and digital transformation consulting."*

Robert Half has been less vocal about specific initiatives and notably absent from M&A, preferring a build vs. buy approach. Like others, it uses AI and machine learning in its candidate/employer matching engine, as well as for micro-targeting and lead prioritization. It offers a job search mobile app but it appears to lack meaningful differentiation from others. Although it was the first major staffing company to allow anyone to go online and see its candidate database, it appears to us that it has been more measured in its pace of innovation.

ASGN 2018 annual report: *"We continue to benefit from secular changes that are driving our markets forward. These include rapid technology change and adoption; a continued shift towards variable, cost-effective delivery models; labor and immigration legislation and demand for value-added services. These secular changes require specialized technical talent in areas such as cybersecurity, analytics, artificial intelligence and cloud services."*

ASGN has primarily used M&A to strengthen its position in attractive skill verticals and add higher value capabilities/expertise. With a focus on more resilient skill categories (technology, IT, digital, creative, engineering), it already has an agility advantage relative to most peers, which has enabled it to outperform the industry consistently over time.

Exhibit 105: ASGN positioned across a range of increasingly specialized services



Source: ASGN investor presentation (June 2019)

Adecco 2018 annual report: *"We are building businesses in attractive adjacent markets, to capture new opportunities in high-growth, high-margin segments. This includes online versions of our offline businesses, such as Adia (staffing) and Vettery (permanent recruitment), as well as businesses such as General Assembly (up/reskilling), which strongly complement our other brands and leverage workforce megatrends. We want to be the digital leader in our industry, disrupting it from the inside by bringing together the best of HR solutions with the best of tech, and leveraging our domain knowledge, data and B2B distribution."*

Within its broad future of work strategy ("Perform, Transform, Innovate"), Adecco made a move in the upskilling/reskilling space with the 2018 acquisition of General Assembly – a firm offering training boot camps and programs for technical skillsets in high demand (data science, analytics, software engineering, digital marketing, etc.).

Exhibit 106: Adecco's approach to the future of work

Source: Adecco 2018 annual report

Within our U.S.-based staffing services coverage, we believe ASGN is best-positioned to succeed in 2025 and beyond.

ASGN's client base consists of large enterprises (Fortune 500/1000 companies) where it provides highly educated professionals in attractive and resilient skill verticals (ie. IT, creative, engineering, and sciences). At the same time, we believe they are also a first mover in the "statement-of-work" space, helping to create barriers to entry for those coming next.

Manpower has been a leader in embracing the advantages of innovative technology and digitalization; it also has a broader service portfolio which includes talent management and MSP/RPO capabilities that support a secular trend toward outsourcing, and should help offset its skill mix that we see as more vulnerable to automation risk.

Though we believe portions of Robert Half's business have exposure to automation risk (e.g., OfficeTeam), the company has taken a less visible approach exploring cutting-edge technologies relative to some others to date. In addition, the company's high-return business model/attractive balance sheet has potential to support incremental investments, and the Protiviti consulting business should help elevate its value-add to a certain extent.

Lightening up

Migration towards asset-light business models and getting more out of smaller physical footprints. For over the past century, the value of industrial manufacturers was traditionally tied to the scale of their physical assets and footprint—whether it be the number of brick-and-mortar distribution branches, manufacturing facilities, installed base, fleet of vehicles, etc. But in the past decade, there has been a paradigm shift as the "digital" has arguably overtaken the "physical" in their long-term strategic value. With the advent of software-as-a-service and data analytics, OEM manufacturers and capital equipment customers alike have learned to produce more with less, streamlining their tangible asset load while leveraging the resources they retain more efficiently and with greater utilization. The benefits of an asset-light footprint are easy to define. Capital equipment and inventory depreciate over time and are costly to relocate or replace when demand trends or geographic needs suddenly change. In addition, entrenched networks of physical assets often prevent companies from adapting to changing business needs in a rapid and agile manner. As a result, within the industrials, there has been a growing preference among both investors and management teams for asset-light business models that can generate attractive cash flows with relatively low capex and working capital needs. Within our coverage, the consummate example of this trend is Roper Technologies, which reached a negative working capital milestone in 1Q17 thanks to its prescient and early embrace of SaaS and asset-light businesses.

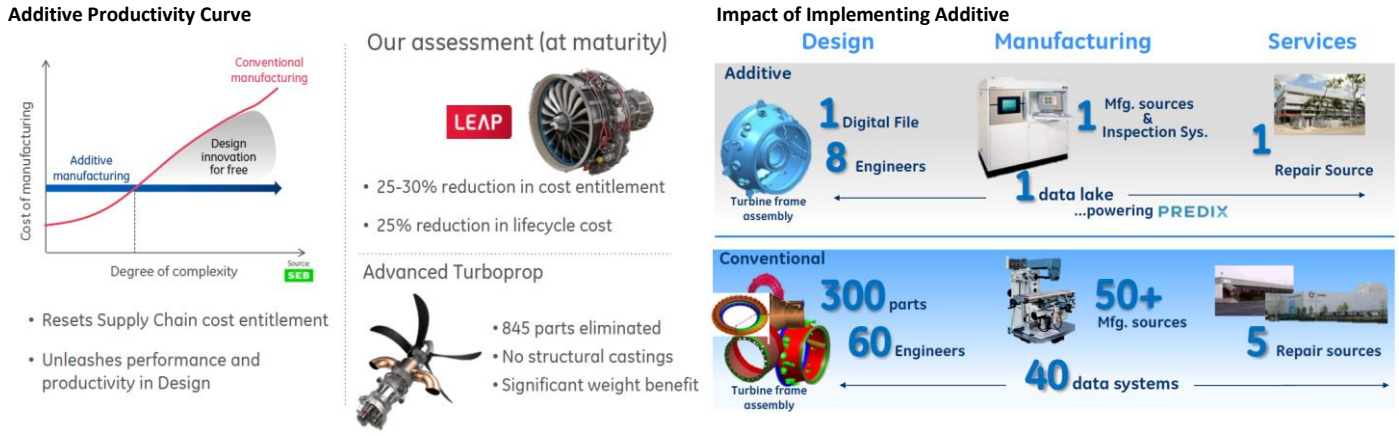
Expanding services and aftermarket to extract more returns from physical installed base. Within the industrials, a typical strategy for OE manufacturers is to price the initial equipment sale as a "loss-leader" and then capture the actual returns from the profitable stream of aftermarket consumables, parts, maintenance, and servicing. As an example, over the course of their economic life, GE's aircraft engines should generate aftermarket revenues totaling ~8x the initial purchase price of the OE installation. Similarly, Flowserve's pump installations generate aftermarket revenues that are ~9x the initial purchase price. More importantly, to varying degrees, these aftermarket revenues always carry higher margins than the initial OE sale, cementing their importance to the companies' bottom lines. As companies' software offerings for data analytics and predictive maintenance become more sophisticated, we expect that their service/aftermarket capabilities will become a more integral pillar of their value proposition. For instance, though Evoqua already generates ~$0.22 of annual service/aftermarket revenues for each $1.00 spent on capital projects, it is working to enhance its service capabilities with its new Water One software suite, improving its win-rate for service contracts and its ability to push for premium pricing.

By implementing 3D printing within industrial manufacturing supply chains, companies can achieve cost savings, faster production cycles, and more flexibility in product designs vs. traditional manufacturing paradigms

3D Printing is Revolutionizing Manufacturing Processes

3D printing offers a new paradigm for engineering design and manufacturing. 3D printing, also known as additive manufacturing, is a process in which materials are joined under computer control to create three-dimensional objects. The process features machines laying horizontal cross-sections of versatile metals or other raw materials layer-by-layer by following digital blueprints drawn using computer-aided design (CAD) software. Essentially, the part is "printed" from the bottom up, leaving behind minimal waste compared to traditional welding and machining. The benefits of 3D printing are myriad: it speeds up the design-build-test cycle by allowing designers to immediately gauge the viability of a product and incorporate design changes; it enables the production of customized components at reduced cost and time; it reduces long supply chains, manufacturing footprint, and waste; and it reduces the cost, effort, and skill barriers to produce complex parts. For example, a single digital file with eight engineers in a single manufacturing source can use additive manufacturing to build what may have taken 300 parts, 60 engineers, and +50 different manufacturing sources by using conventional processes. As 3D printing costs go down and adoption becomes widespread, we believe that additive manufacturing will become a key competitive factor that differentiates industrial companies within the market. Advocates of 3D printing predict that it could counter globalization, as end users will in-house more of their own manufacturing rather than source products from other suppliers. Although traditional manufacturing may still hold a place in the competitive landscape, the next decade will likely reveal a rapid increase in the innovations made possible by 3D printing.

Exhibit 107: Additive Manufacturing Overview



Source: GE

Fast-growing startups are revolutionizing additive manufacturing. Today, advances in technology are further pushing the envelope on what 3D printers are capable of producing. New generations of 3D printers are able to create prototypes in materials that range from carbon fiber, to fiberglass, to Kevlar, to stainless steel, and even to titanium. Many of these advances in 3D printing are being led by emerging startups. For instance, Desktop Metal is a technology company founded in 2015 that tied for the distinction of being the fastest-growing "unicorn" in US history thanks to its innovative end-to-end 3D printing systems that were designed for both small production runs and large-scale manufacturing. The company has attracted financing from a portfolio of strategic partners and investors, including Ford Motor Company, GE Ventures, BMW iVentures, Lowe's, and much more. Desktop Metal has also claimed that its upgraded industrial scale systems are the fastest metal printers in the world. Ultimately, we believe that Desktop Metal and other startups of its ilk are worth monitoring and can hold the key to the next frontier of additive manufacturing.

Case study in additive manufacturing: GE Aviation

The design challenge: Over a decade ago, GE and Safran's joint venture, CFM International, began work on designing a new, fuel-efficient jet engine for passenger planes. Part of the goal for the new engine design was a reduction in fuel consumption and emissions, and the key to this breakthrough would be the creation of a complex new fuel nozzle. However, the interior geometry of the nozzle tip was incredibly intricate and complex, requiring over 20 parts to be welded and brazed together and effectively making the design too onerous and costly to be manufactured at scale. GE's engineers were stumped by this manufacturing challenge that seemed impossible to overcome.

The solution: At the time, GE Aviation engineers had been working with a small additive manufacturing company named Morris Technologies, which would help GE print prototypes of engine parts and iterate on new designs. GE approached the company with the fuel nozzle design and asked whether its 3D printing machines were capable of producing it efficiently and accurately. As it turned out, not only did Morris's machine successfully fuse all 20 parts into a single unit seamlessly, but the end product also weighed 25% less than an ordinary nozzle and was over five times as durable. After GE Aviation acquired Morris Technologies in 2012, the company began efforts to leverage additive manufacturing to mass produce the innovative new fuel nozzle, which would be installed within the company's next flagship jet engine, the LEAP, which officially began powering commercial aircrafts in 2017.

Latest milestone: As of October 2018, GE has now 3D printed over 30,000 fuel nozzle tips for its state-of-the-art LEAP engines. These nozzle tips are manufactured at GE Aviation's plant in Auburn, Alabama, which is GE's first site for mass production that specifically leverages the additive manufacturing process. Currently, there are over 40 printers at the facility producing parts using metal powders.

Exhibit 108: GE Aviation LEAP Engine Fuel Nozzle

Source: GE

Portfolio Agility

For industrial conglomerates, agility can come in the form of portfolio additions or subtractions. Although there are plenty of pure-play companies in the industrial space today, there are still a cadre of multi-industry conglomerates operating across dozens of end markets. Given rapid secular changes and evolutions can be hard to predict, it is no surprise management teams actively cultivate their portfolio of businesses through M&A and divestitures. M&A spending has averaged ~30% of total Multi-Industry capital allocation activities over the last 10-years (M&A, capex, dividends, and repurchases). We expect this trend to continue. To stay agile in the industrial space, it is important for managements to foresee emerging trends and find new or complementary business targets to leverage their current set of offerings. There has been an increasing focus for industrials to acquire software

companies to deliver customers more than just equipment and offer things like predictive analytics and other valuable data insights. Portfolio additions and subtractions are important for multi-industry industrials to stay at the forefront of their markets and to make investment in secular growth trends.

- **Entering an industry with secular tailwinds.** The fastest way for a Multi-Industry company to increase exposures to secular growth trends is through M&A. An example of this is Fortive's $0.8 billion acquisition of Landauer. Landauer provides complete radiation dosimetry services (measurement, calculation, and assessment of the ionizing radiation dose absorbed by the human body) to hospitals, national laboratories, nuclear facilities, and other industries in which radiation is a potential threat to employees. The acquisition is attractively positioned to secular growth given the company's focus on condition-based monitoring, safety, and software/SaaS.
- **Exiting an industry with secular headwinds.** An example of portfolio pruning due to secular shifts in certain end markets was Honeywell's spin-off of its Turbo business into Garrett in September 2018. Honeywell's Turbo business was the leader in turbochargers for passenger cars and light and heavy-duty trucks. A secular shift is underway as vehicles transition to electric propulsion from internal combustion engines (ICEs). Given Turbo's ICE focused business, the company operates in an industry being disrupted from new technologies. By exiting a business in secular decline, a company can free up capital for further M&A or internal investments geared towards higher-growth end markets.
- **Using M&A as a proxy for R&D spending.** Companies can use M&A as a means for accelerated research and development spending. Acquiring a business to quickly increase offerings gives a company the ability to have a broader or higher-tech portfolio for its customers. This can save the firm both money and years of research and development efforts. An example of this is Xylem acquiring Sensus for $1.7 billion. Sensus is a leading provider of differentiated communication systems, metering technologies, and data analytics solutions that enable the intelligent usage and conservation of water, gas, and electric resources for utility operations. In addition, Sensus maintains a differentiated Software as a Service platform known as FlexNet, which is an advanced, scalable solution for remote monitoring and diagnostics of water utility equipment. The deal vaulted Xylem into smart water networks, data analytics, and new SaaS opportunities, keeping it at the forefront of water technology offerings.
- **Keeping business lines smaller, more decentralized, and more entrepreneurial**. To stay nimble in a competitive landscape, companies can concentrate on more decentralized operating models where smaller and more entrepreneurial business lines focus on their respective core strengths. Smaller and leaner operations have a better ability to quickly adapt to new threats and emerging trends. Roper, for example, truly embraces the Multi-Industry model by structuring its enterprise as +40 distinct businesses each headed by a different operating company president and running independent P&Ls. There is no unifying ERP system, and each business is given enough autonomy to operate with a discrete strategy. The result is the company looks more like +40 separate micro-caps bound loosely together by a common ideology and operating culture. This has led to entrepreneurial-like businesses that are quick to react to any given change.

Analyzing the additive manufacturing value chain

Additive manufacturing is a process to create a physical object from a digital model layer by layer

Overview

Additive Manufacturing (AM) is a wide definition for the process of creating a three-dimensional physical object from a digital 3D model. The process is usually carried out by laying down many thin layers of a material in succession. Whilst widely regarded as synonymous with 3D printing, we see additive manufacturing as the broader application technology whilst 3D printing is a sub-process.

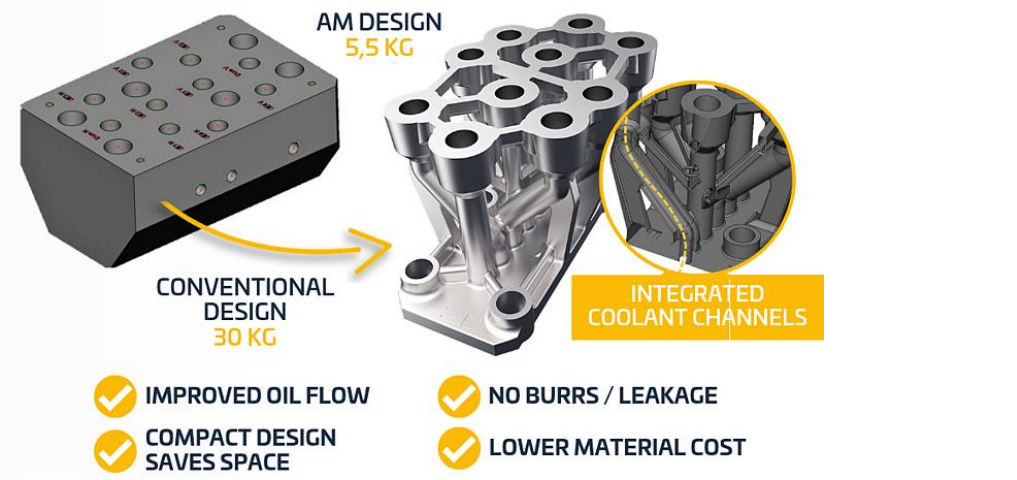
We can characterize the AM value chain by four stages – design, materials, additive production and post-processing. Design not only incorporates the design of the component but also the manufacturing process. There are over 100 different materials currently available for AM, mainly polymers and metals but also ceramics and composites. The additive production stage refers to the AM technique used to produce the components.

Currently around 90% of AM production use polymers with around 10% metal. Plastics have a broader range of applications but the industrial relevance of metal powders is higher and hence growing as AM becomes more industrialized.

Advantages are now well known

By now, the advantages that additive manufacturing techniques can bring over traditional manufacturing are reasonably well known. The principal benefits of additive include improved design flexibility (more complex and customizable parts can be made); material efficiency (lower level of wastage); and production flexibility (changeover costs are minimal compared to traditional methods).

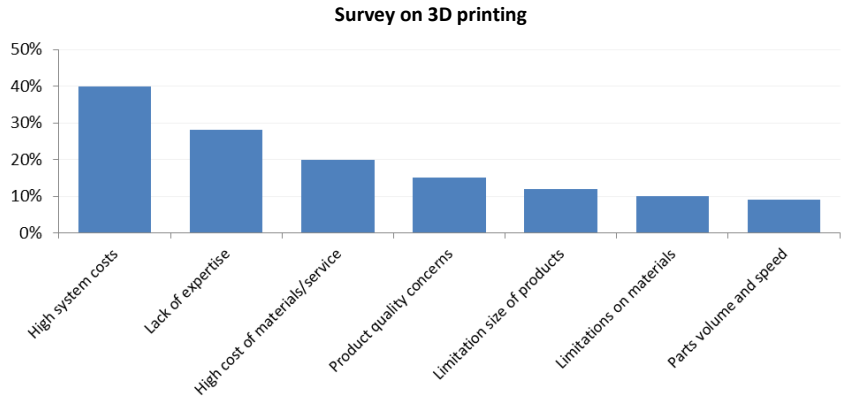
Exhibit 109: Additive manufacturing can present a number of advantages over traditional techniques



Source: GKN powder Metallurgy

The disadvantages generally centre on cost (industrial metal printers can cost over $1m and material costs are much higher than used in traditional manufacturing), speed of production (less of an issue for current applications but a hindrance for mass production adoption) and a more limited compatibility of materials. An EY Global 3DP survey in April 2016 of 900 manufacturers showed 40% of respondents saw high costs of the system as a hurdle to implementing 3D printing.

Exhibit 110: EY survey on 3D printing implementation barriers – system costs are the biggest obstacle to adoption



Source: EY Global 3DP Study 2016

The value chain – equipment, materials and service providers

The equipment landscape has already become very competitive, and the pure-plays have begun to see slowdowns in growth rates and deterioration in profitability. Systems are typically capital expenditure items and so inherently more cyclical. Meanwhile, service companies continue to see high growth rates whilst profitability remains steady. The revenue profile is far less cyclical, as a consequence mainly from on-going use of the original equipment. There is an expertise and quality requirement associated with service that could see companies with existing (traditional manufacturing) service networks well positioned to capture AM-related growth.

Material providers' revenue will also be less cyclical, in our view, as it will be related to production of parts rather than capital expenditure budgets. We see scope for powder manufacturers to differentiate with their respective technologies – there does appear to be a technological barrier to developing additive-specific powders. Knowledge and expertise across the supply chain, whether through vertical integration or partnerships, will be important to overcoming this. The high capital intensity also lends an advantage to existing powder metallurgy manufacturers.

Systems providers

Key systems providers – a competitive landscape

The systems space has become crowded quickly.

A detailed analysis of the 3D printer systems manufacturers themselves are outside the scope of this report. Systems providers include Stratasys (listed, US), 3D Systems (listed, US), Arcam (now owned by GE), EOS (private, German), Concept Laser (now owned by GE, German), SLM Solutions (AM3D GR, not covered), ExOne (XONE US, not covered), Voxeljet (VJET US, not covered) Ultimaker (private, Dutch). Traditional machine tool manufacturers such as DMG Mori (GIL GR/6141 JP, not covered) and Trumpf (private, German) also have 3D printing systems offerings, as does engineering/metrology company Renishaw (RSW LN, not covered). 2D printer companies (e.g. HP Inc.) have also moved into the 3D printer space with success. One can see that the market has the potential to be very competitive with systems providers moving into the space from several avenues (e.g. pure plays, traditional machine tools, traditional printing).

Different systems providers focus on different technologies – for example, the offerings of Voxelijet and ExOne are centred around binder jetting; SLM Solutions, EOS and Concept Laser machines are based on selective laser melting for metals, whilst Arcam's machines are electron

beam melting machines. GE has ensured it has multiple technologies. The different technologies have benefits for various applications – e.g. binder jetting is better for higher volume, sand casting; powder bed fusion is better for low-volume, high-density parts whilst free form deposition methods are better for the most complex parts.

Services

Scope of services

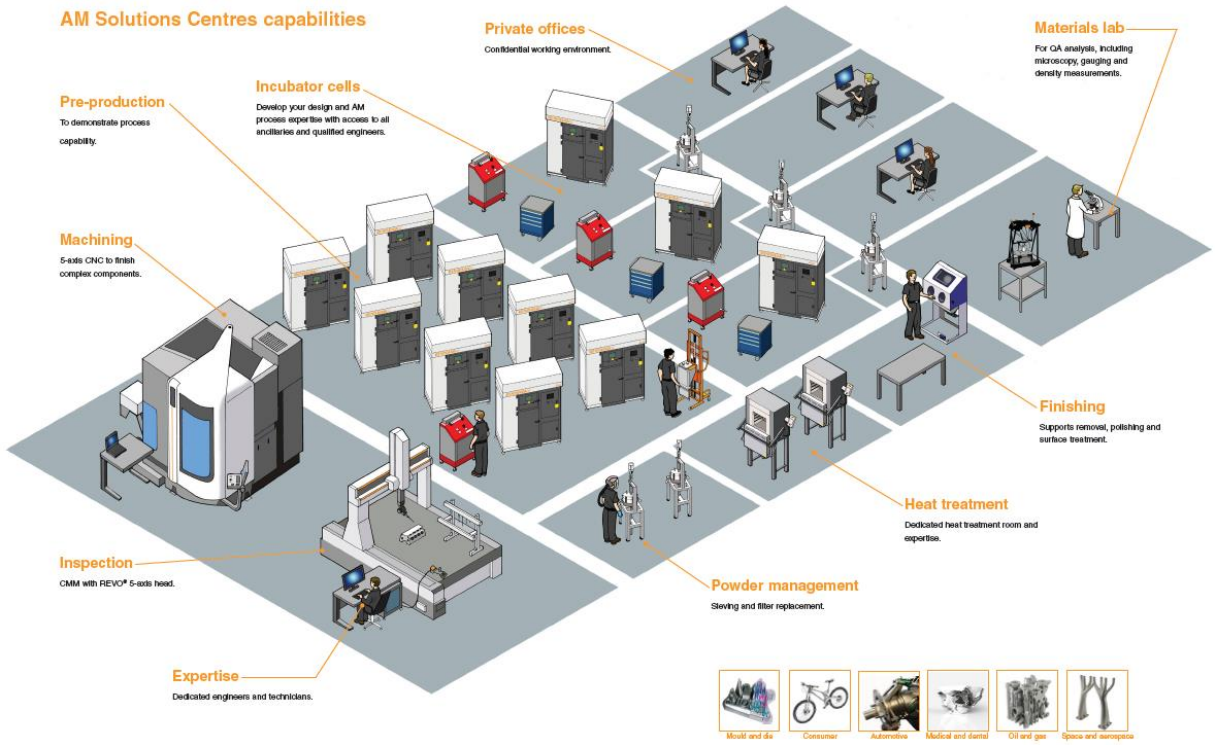
We see the definition of services within additive manufacturing as the following:

- Outsourced (contract) manufacture – this where customers, instead of investing in their own 3D printers and expertise, use a third party to carry out production (rapid prototyping, short-run production, moulds, tools) as well as ancillary services.
- Consulting around design – additive manufacturing brings its own product design challenges where external expertise may be required.
- Ancillary services – as with traditional manufacturing, there are parts of the value chain that can be outsourced such as finishing and post-processing.

We are not including services that are highly specific to the machine manufacturer such as spares and maintenance of the printers themselves.

If we look at the diagram below, we can gain an idea of what a service or solutions centre might entail. In this case, the company showing the service concept is Renishaw (not covered).

Exhibit 111: An example of an AM service centre – in this case a Renishaw Solution Centre concept



Source: Renishaw

Services can help overcome several barriers to implementation

If we look at the EY survey in Exhibit 110, it shows that the two biggest hurdles to further adoption of 3D printing are high system costs and a lack of expertise. This is one of the reasons why we expect continued high growth for AM service companies. Whilst overall 3D printing industry sales are expected (e.g EY forecasts) to grow ~20% p.a. over the next five years, we expect service sales growth to be higher.

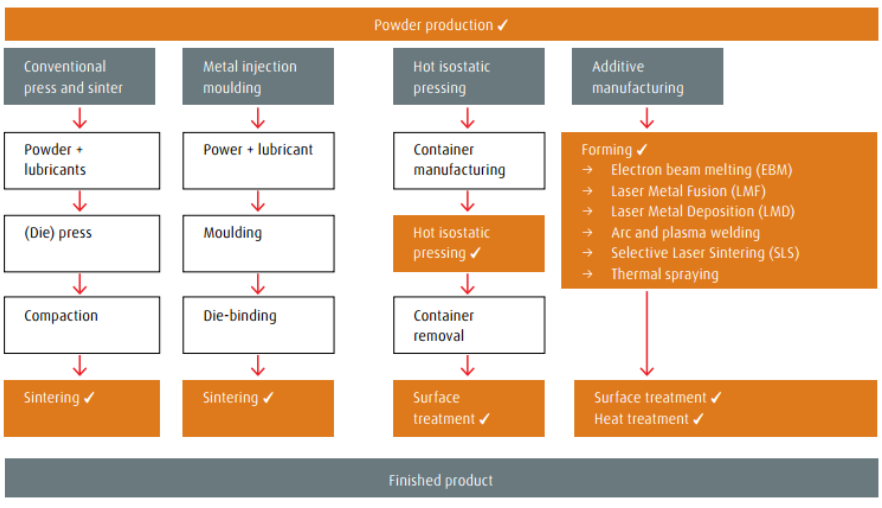
Traditional services/methods still have a place alongside AM

As Exhibit 111 neatly illustrates, additively manufactured parts will still require some degree of post-processing. This could include a combination of machining, heat treatment and coating amongst others, suggesting that there may be some synergies with existing service businesses such as Bodycote and Oerlikon (although for the latter AM is currently very much a stand-alone strategy). On the inspection side, as AM becomes more industrialised, we expect that tolerances will become more important. The inspection of parts with potentially more complex shapes than have traditionally been produced on an industrial scale could provide an opportunity for metrology businesses such as Hexagon (HEXAB SS, Outperform), Renishaw, Nikon (7731 JP, not covered) and Zeiss (private, Germany)

Materials (metal powders)

Metal powder for additive manufacturing has two obvious structural drivers: 1) as volumes of additive manufacturing increase, so does the volume demand for the powders that form the printed components; 2) given powder quality is determinant of quality and consistency in the final components, as complexity of parts using 3D printing increases, so does the demand requirement for higher-tech metal powders. However, the competitive landscape is complicated and it is not yet clear where the competitive advantages lie.

Exhibit 112: A representation of the value chain across traditional powder metallurgy techniques and additive manufacturing

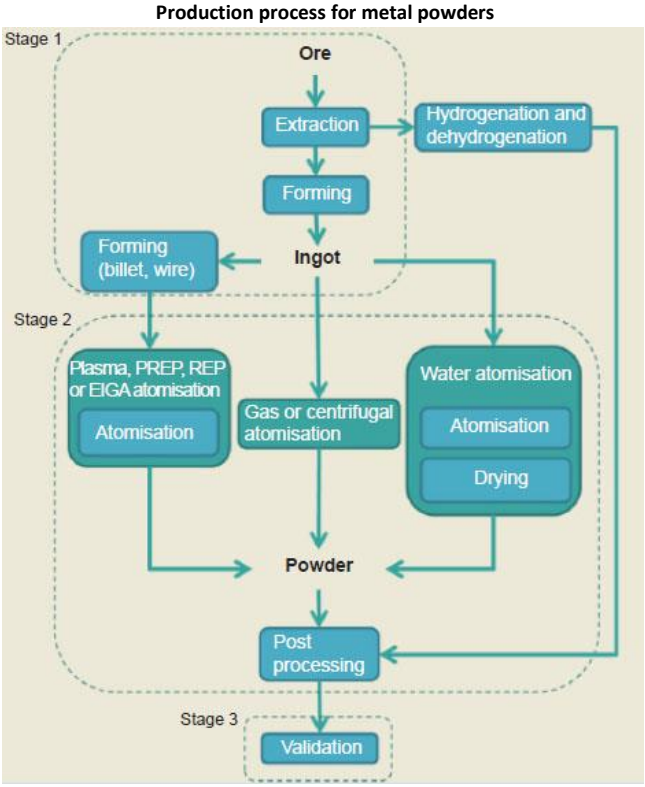


Source: BOC (Linde Group) presentation

Metal powders are made by atomisation

Metal powders for additive manufacturing are typically nickel-based, titanium, aluminium and cobalt-based alloys. Steels (stainless and tool) are also used. This is substantially different from traditional powder metallurgy where the vast majority of powders are based on steel or iron. Powders are typically made by a process known as atomisation. Atomisers are very expensive pieces of equipment (can be ~$10m investment).

Exhibit 113: Powders are made from ores, which are atomised through a water, plasma or gas-based method



Source: Johnson Matthey 2015

At the moment, equipment suppliers hold strong influence in the use of materials. Many of them specify or validate which powders can be used with their machines. This could fade as machines become more standardized/commoditised

Key criteria for powder in additive

According to information on the Renishaw website, the characteristics for successful powder bed fusion are powder flowabilty (size, shape, free from moisture and electrostatic forces), close packing of particles and spherical particle shape. These lead to a consistent and predictable dosing and layers. We see an advantage for powder developers who are more widely involved in the AM ecosystem such as the partnership between Oerlikon (powder, services) and GE (equipment, powder and services).

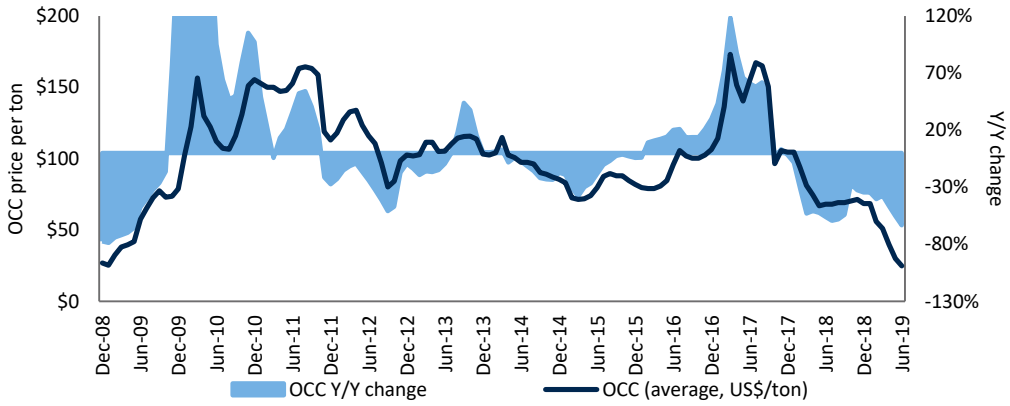
Ability to react swiftly has proven effective for waste companies

In response to China's series of contamination restrictions, companies in the US with recycling operations have been forced to alter the way they structure contracts with customers. In what was primarily a more commodity-driven, rebate-based business model previously (where companies would then sell recyclable materials they collected at relevant commodity prices), it has now evolved into a pay-for-service contract structured with additional fees charged based on contamination levels.

In order for a structural paradigm shift such as this to be effective, it must be both sustainable and economically viable. While the new contract structures were initially implemented in the second half of 2018, it took several quarters before the effects were truly felt by the waste majors. Accordingly, recycling performance and related commentary from Q2/19 earnings

season soundly beat consensus expectations – with some companies actually improving profitability in the segment on a Y/Y basis (ex. Waste Management was able to offset a ~33% drop in commodity prices during the quarter and generate an incremental ~$6MM in EBITDA). We view this rather rapid turnaround in a troubled segment as further cementing the importance swift and decisive action can have when external forces materially impact an industry. That said, we do acknowledge the caveat that waste companies tend to exhibit strong pricing power relative to other industries (and thus were able to quickly and successfully pass on these amended contract structures to customers). However, we also believe that if the industry had stood pat and "waited for the storm to pass", recycling operations in North America would be in significantly worse shape than they are today.

Exhibit 114: Through swift action, waste companies were able to offset historically low commodity prices



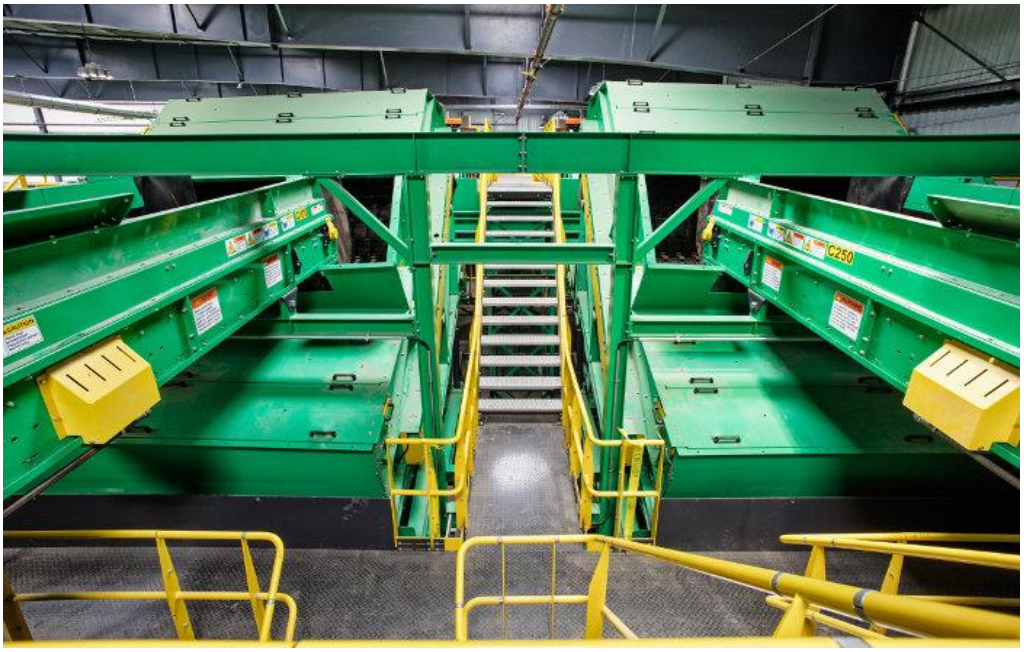
Source: RISI, RBC Capital Markets

Positive is better

Strict contamination standards imposed by China (and, subsequently several other Asian countries) on North American recycled materials sent ripple effects throughout the recycling industry, forcing the large waste majors to alter their operations and business models. To combat this dynamic, waste companies have elected to invest in "next-gen" materials recovery facilities (MRFs) employing various technologies to further streamline and optimize recycling processes.

One such technology involves the use of "positive sort" recycling vs. traditional "negative sort". Positive sorting involves targeting paper and other recyclable materials early on in the system to separate it quickly and cleanly (it is believed that positive sorting can reduce contamination levels down to 0.5% - enough to pass China's policies). Negative sorting, on the other hand, involves picking out contaminated materials from a recycling stream and is often less effective than positive sorting when it comes to reducing contamination levels. With growing adoption and increased capital investment from waste companies, we see the potential for these types of machinery to further creep up the innovation curve and begin cementing themselves in the day-to-day operations of recycling business lines.

Exhibit 115: Positive sorting has the potential to alter recycling operations for the better



Source: Van Dyk Recycling Solutions

Culture will be key as waste companies look to recruit future talent

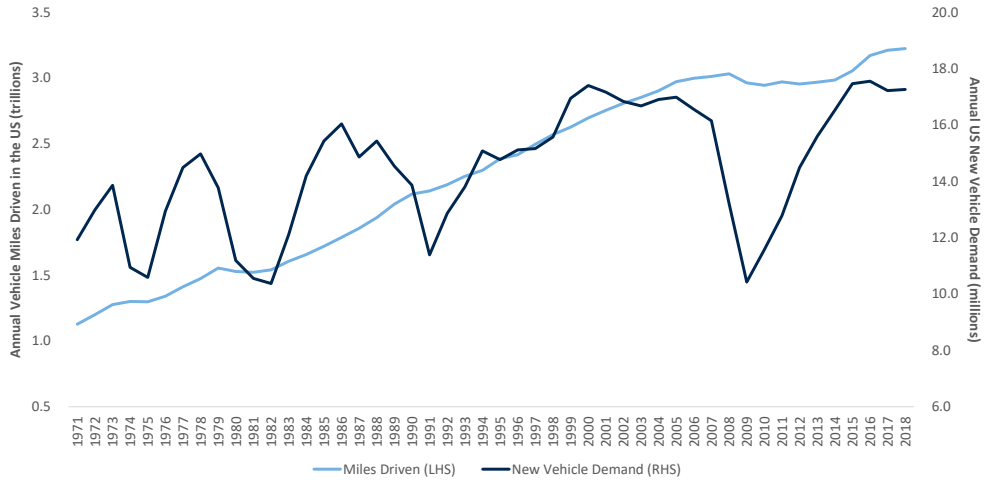
A theme growing in importance amongst waste majors is an emphasis on corporate culture, particularly as it relates to placing the safety and needs of front-line employees at the top of the company's priority list. Recruiting and retaining the next generation of front-line workers (particularly drivers and mechanics) has been a growing focus. Millennials in particular are a critical group, with the waste majors investing in recruitment and technology to make the industry more appealing, which in turn is changing the narrative surrounding front-line occupations in the space. We expect to see continued investment from the waste majors in employee initiatives to further drive engagement and increase retention rates. We also anticipate companies will get more creative with how they target younger generations, and expect that the use of social media and an emphasis on more progressive work-place dynamics will become increasingly pervasive as we transition out towards 2025 and onwards.

Going from selling units to selling miles

When robo-taxis come to fruition, it would enable a powerful business model shift. ***Companies go from selling units to selling miles.*** For example, right now when an automaker sells a vehicle in the US we believe they take in, on average, ~$30k of revenue. The vast majority of that revenue is recorded up front when the dealer takes delivery of the vehicle and then there could be some aftermarket or service revenue over the life of the vehicle. However, now imagine that same vehicle is put into a robo-taxi fleet. As per our prior analysis, that vehicle at scale might cost $50,000, but it could put on 70,000 miles/year and we estimate consumers would pay ~$0.50/mile. That means $35,000 of revenue just in year 1. But of course, that vehicle may be able to run for 200,000 miles, or potentially more if it's an electric vehicle – which we believe may have a longer useful life. If that vehicle runs for 200-300 thousand miles, then the lifetime revenue is now $100,000-$150,000 or a 3x-5x increase.

Further, miles driven is meaningfully less cyclical than units sold. We would also argue that there is the potential for miles driven to increase as robo-taxis are now providing affordable mobility to those that previously may not have had access (youth, elderly, disabled, etc.).

Exhibit 116: Miles driven vs. Demand in the US, 1971-2018



Source: NHTSA, RBC Capital Markets

Robo-taxis may also begin to take miles from public transportation or even replace rail or regional air flights. Further, there is some academic thought that shows that technological improvements in mobility increase sprawl, and hence miles needed to be driven. Italian physicist Cesare Marchetti found that through history, people have kept the average time spent per day for travel constant, even though the distance may increase because of advancements in transportation. This could be relevant for autonomous vehicles, as if they reduce congestion/traffic, then sprawl could proliferate. The below chart is from Marchetti's 1994 paper entitled *Anthropological Invariants in Travel Behavior*. The chart below shows city dimensions and speed of transport in Berlin. The evolution of the city size of Berlin increased as transportation technology improved from a radius of 2.5km as walking was the predominant mode of transportation to 20km as cars were introduced.

Exhibit 117: Figure from Marchetti's Anthropological Invariants in Travel Behavior

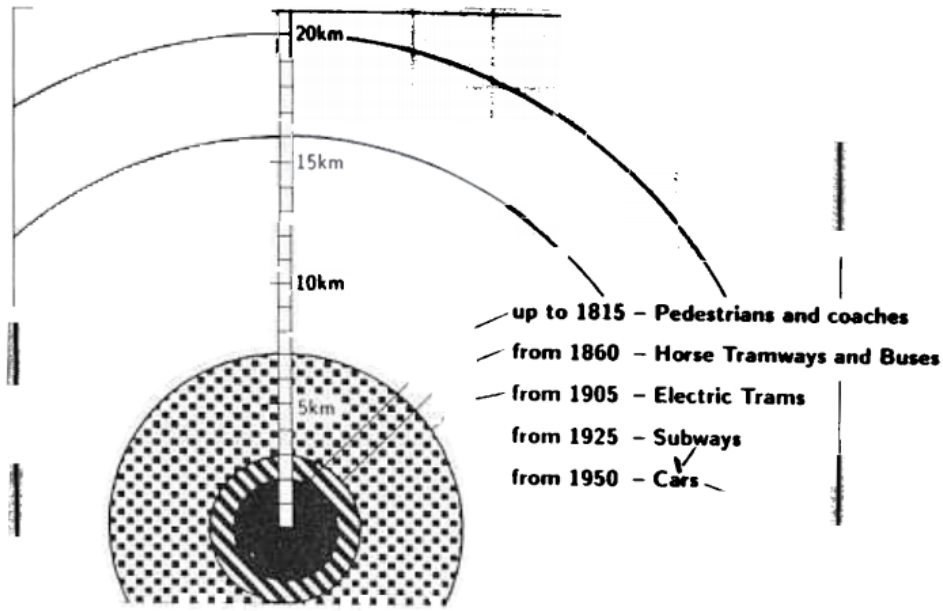


Fig. 2. City dimension and speed of transport: The case of Berlin. The fact that the "daily radius" depends on the speed of transportation is clearly manifested by the evolution of the size of the city of Berlin. The Berlin of 1800 was very compact with a radius of 2.5 km, pointing to a speed of 5 km/hr, the speed of a man walking. With the introduction of faster and faster means of transportation the radius of the city grew *in proportion* to their speed, and is now about 20 km, pointing to a mean speed for cars of about 40 km/hr. The center of the city can be defined, then, as the point that the largest number of people can reach in less than 30 minutes. Reducing the access to the geometric center, for example, through zoning, can displace the functional center elsewhere, for example, outside the city. Shopping centers are a typical consequence of poor transportation toward the center of the city.

Source: C. Marchetti, Anthropological Invariants in Travel Behavior, Technological Forecasting and Social Change 47, 75-88 (1994).
http://www.cesaremarchetti.org/archive/electronic/basic_instincts.pdf

Finally, robo-taxis could be a more profitable business. GM has indicated they believe ~20-30% margins are possible for SAVs, which is far superior to any auto operating margins in today's world. In our cost per mile economics analysis detailed in a prior section, we assumed a marginal operator return of 15%.

Actual business model still a bit uncertain

We will admit that the actual business model form, and how it evolves, is still a bit uncertain. It could be transaction-based (which is what our model assumes), subscription-based, advertising-based or something else. Even if it is advertising-based, then the cost to the consumer might approach $0/mile; however, there would be other forms of compensation to make sure the owner/operator of the vehicle earns a return. For instance: What if the operator of the vehicle were able to give you a free ride since advertisers would be able to show you highly targeted advertisements? What if a retail store or restaurant paid for your autonomous ride to ensure the consumer comes to their establishments (potentially the highest ROI "advertising" they could make).

We also note that it is very likely that there will be different classes or features of autonomous vehicles on demand. For instance, a luxury vs. mass market offering (we have already seen Waymo embark on this with the order of Jaguar i-Pace vehicles for a premium offering). However, there could also be vehicles geared towards family use (with car seats if needed) or special event use (i.e. going with a large group to a sporting event or concert).

Within automotive, traditional automakers such as Ford, GM, and Tesla all plan to offer a transportation service revolving around their fleet. While commercialization is still likely a few years away (varying timelines), these remain key pieces to the longer-run stories.

- Ford: In 2017, Ford purchased a stake in Argo AI, a self-driving startup. The deal was intelligently structured to allow employees to have equity participation, which should help attract talent (a problem we always feared for OEMs). Ford has since acquired other smaller mobility technology companies such as Autonomic and Transloc to develop its open Transportation Mobility Cloud platform and improve rider experience through dynamic routing capabilities. Since then, Ford has set up "Ford Mobility" which consists of two LLCs (and holds the Argo investment), and increases its ability to take outside investment (i.e. VW). Ford plans to utilize partnerships to help drive demand (and broader reach of services), having already secured agreements with Postmates, Domino's, Walmart and Lyft.
- GM: In 2016, GM began preparing for the future of mobility by acquiring Cruise Automation, a self-driving vehicle startup. At the time, Cruise was developing hardware and software that would allow a vehicle to drive autonomously on the highway, and had been working on technology that would allow a vehicle to be fully autonomous. Cruise's move to inside GM has allowed for more seamless interaction and a faster, more iterative development process between autonomous development and vehicle production, which could be a competitive advantage vs. new entrants as it enables speed of iteration.
- Tesla: This past spring, Tesla announced plans for a robo-taxi network through its FSD offering. The company is manually annotating images captured from cameras on its vehicles to build a neural network for vehicles. Once running fully autonomously, the company plans to allow owners to put their vehicle into a fleet (with Tesla taking a cut) that passengers could summon through a ride sharing application. From a financial perspective, Tesla estimates $30k GP/vehicle/year (~$200k NPV), which compares to YTD average of just $11.4k GP/vehicle on a one-time sale. If TSLA truly believes NPV is ~$200k/vehicle, then there is a scenario where one could see them own all of their vehicles in the future (a completely different business model). However, Tesla's balance sheet would likely constrain them from pursuing this scenario.

The need to remain agile has also resulted in partnerships/alliances with other automotive competitors to help offset the vast amount of resources and capital needed for these initiatives and fill capability gaps. In the cases previously discussed, this has led to strategic relationships between Ford/Volkswagen and GM/Honda. For ride sharing companies Uber and Lyft, we have seen partnerships with Lyft/GM, Uber/Daimler, or technology companies such as Waymo (Google) with FCA.

Others have remained agile and attempted to close capability gaps through M&A as a proxy for R&D spend. On connected vehicles, Lear acquired Xevo, which attempts to boosts the in-car experience by delivering infotainment, e-commerce, and insights customized from data captured through AI. On the push towards electric vehicles (EVs), Borgwarner acquired Remy International for its electrical components capabilities, Sevcon to assist with onboard charging, and more recently, a JV with Romeo Power to boost battery offerings. Similarly, Dana acquired SME Group to combine its existing portfolio with SME's low-voltage motors to expand its OH EV capabilities.

But remaining agile extends past a company's product/service offerings to efficiencies. We have seen recent initiatives to decentralize operating models, where smaller and more entrepreneurial business lines focus on their respective core strength to adapt to competitive threats or emerging trends. Companies have exited business lines that had an unclear path to profitability, rather than focus on global scale. Instead, de-centralizing the business and focusing on regional scale could generate greater profitability, reversing prior logic (i.e. GM's

decision to exit Europe or Ford's decision to exit its commercial truck business in Brazil). Others have focused on creating leaner operating structures for quicker decision making (less bureaucracy) enabling greater agility/autonomy. Ford, for example, is looking to become more "fit" through optimizing marketing/sales and creating flexible/modular vehicle architectures. On the supplier side, Adient has moved to a regional focused model vs. a product-focused model, to enable regional leaders to reach quicker decisions. While near term, these restructuring decisions may pressure profitability, longer term these are likely the right steps in positioning companies for the future – which arguably could look like an entirely different mobility landscape.

Best Positioned: Aptiv, GM

Aptiv (APTV): The company has positioned the portfolio to be a key supplier for the signal and power architecture needed in vehicles of the future, autonomous driving and connectivity. Aptiv is also adopting new business models and is one of the first companies to show real-world monetization of their autonomous vehicle investment.

General Motors (GM): An automotive leader in the robo-taxi opportunity through its Cruise division. This opportunity allows them to shift from selling units to selling miles. Selling miles allows GM to enter the TaaS field, which could provide a much larger TAM with higher potential profits, and reduced cyclicality.

The next wave of innovation is coming to home construction

The homebuilder and building products space has historically been slow to adopt innovative practices – further limited by the cyclical nature of the end markets. However, the longevity of the current cycle as well as advances in software, data analytics, and robotics have all brought the cost curve down for investments in innovation. We think that this time around, innovation becomes necessary. Rising costs are making flexibility and the ability to adapt quickly a requirement for staying competitive, and companies are expressing an intent (at least for now) to invest throughout the cycle.

Automation

To combat rising labor costs stemming from a structural labor shortage and the growth in the gig economy (see Collective Action), we think that process innovations breaking away from the traditional onsite stick and brick construction practices, along with robotics and automation in construction and building products manufacturing, will lead to increased efficiency levels. Today, automation is somewhat limited to repetitive tasks, like fork lifts, cutting lumber, and moving materials. Tasks that are more dynamic and job specific still require human workers. We expect this to gradually evolve in the mid to near term. That said, our sense is that the companies in our space will be partners or buyers of these technologies, not the primary developers or owners.

Offsite Construction

We view offsite construction as representing the biggest opportunity to change the way companies in our coverage universe operate, for both the homebuilders and the building product OEMs. Today's construction consists of preparing and assembling all raw materials onsite in a linear fashion. You can't work on the inside until there is a roof and a roof can only be built on top of walls, but the walls can't be put up until the foundation is laid. It is this linear process that adds significant construction time to the homebuilding process. Not to mention that if there are weather issues, each successive step is delayed.

Offsite construction offers significant promise. This is a phrase that's been written or said for years, without subsequent breakthroughs and a step-function change in construction methods; we believe we've reached a tipping point given the labor and affordability challenges

across housing – and companies are increasingly buying in. Today, offsite construction mainly consists of creating wall panels, roof trusses, floor trusses, and, to a lesser degree, modular construction. More advanced integrated systems exist, but face adoption hurdles due to a number of issues which include varying local building codes (making fully offsite solutions difficult to scale and gain all the necessary approvals), the need for builders to redesign floor plans, and a change in the type of labor/equipment needed on a job site (think crane operators and engineers vs. a traditional framing crew).

By 2025, we expect significant further penetration of offsite construction, both in terms of components and more integrated solutions. While we acknowledge that there is a long way to go from today's manual, linear onsite construction and more automated and custom factory-built homes provide steps to bridge the gap. Homebuilders have teamed up with lumber distributors, offsite construction start-ups (such as Katerra and Entekra), and manufactured home companies to work toward removing bottlenecks, redundancies, and inefficiencies from the process. We've seen first mover actions taken by BMCH, BLDR, SKY, LPX, and KBH to set up and utilize some of the current technologies. Some builders, such as NVR, TOL, and Clayton Homes have made investments internally to expand such capabilities around truss systems.

Homebuilders' ability to reduce the number of floorplans and offer common floor plan elements (kitchen location, bath location, electrical outlets, etc) would be key to allowing the process to work efficiently. For the time being, programs geared to high-volume markets with higher acceptance for cookie cutter communities will likely provide opportunities for pilot programs. Low-rise multi-family developments and single-family rental communities also represent potential for test programs due to the large number of standardized units in each. An ability to be a first mover in adopting such processes could provide key competitive advantages such as reducing building cost, reducing material waste, shortening the build cycle time (increasing returns on capital), less risk for construction delays, and importantly higher levels of quality.

The good news for building products companies is that regardless of whether a home is built onsite or offsite, the insides are largely still the same. On the other hand, while the core products such as flooring, cabinets, doors, and windows will always be needed, it would seem likely that in a fully offsite construction world, vertical integration also becomes more common and some existing building products companies could lose share as a result. Similarly, distributors will need to adapt, partner with, or buy offsite partners in order to avoid being cut out.

Logistics and Fleet Optimization

Data analytics have allowed building products OEMs and distributors to become more efficient in the day-to-day operations. We've seen a wave of investments by a number of building product distributors to improve working capital management through projects such as optimizing yard routes for loading supplies at branches, data-driven delivery routes, hub-and-spoke distribution models in select markets, and fleet tracking to ensure on-time delivery of product to the end consumers. Additionally, investments in customer apps to ease the purchasing, pick-up, and delivery scheduling of products has also helped strengthen the moat around large national distributions relative to the smaller local competitors.

As builders continue to invest in centralized offsite construction, coupled with improving data analytics around every day logistic practices, we anticipate that the optimization trend only intensifies. Building product OEMs also have an opportunity to capitalize on investments and innovations in this realm. Automation and optimization of material management through robotics moving material around facilities, reconfiguring production lines to increase throughput, or using more advanced algorithms to optimize material yield represent

important opportunities for OEMs to enhance levels of profitability and potentially reduce companies' manufacturing footprints.

Alternative and Disruptive Material Conversion

Over time, we've seen a number of disruptive material conversion stories impact entire product verticals within our sector. In the 1980's the roofing market converted from paper backed shingles to fiberglass-reinforced asphalt. More recently, there has been a major shift in the flooring industry toward synthetic polyester carpets. Composite materials have seen rapid growth in the entry door, decking, siding, and tool markets over the past decade. More advanced building materials are surely on the horizon (conductive paints, for one). Companies' ability to invest in new applications of materials should continue to provide significant first-mover benefits.

This will also likely play into an increased focused from companies on environmentally friendly practices. We've seen a number of industries utilize a higher level of recycled materials. Opportunities to reduce the dependency on natural commodities as well as a general push to use materials that allow for cleaner production could provide companies with the ability to improve consumer perception of brands, lower energy costs in production, and even improve cost of capital. For example, OC (which is regularly recognized for its focus on sustainability) was recently able to issue debt at lower rates than many competitors through the issuance of "green bonds." Access to more capital should also allow companies to accelerate other potential investments discussed throughout this report. Relatively healthy balance sheets across the space as well as access to capital at low rates allow major companies to be acquirers of such technologies where smaller private start-ups are more willing to take the risk of developing disruptive products.

Portfolio Reviews

Strategic portfolio reviews have become more prominent over the past few years, as investors and management teams alike have been pushing for de-conglomeration. We're likely to see this continue as companies confront both an evolving cycle as well as longer-term challenges and opportunities discussed in this report. For example, MAS has spun off an insulation installation/distribution division and is in the process of selling its cabinets and windows businesses. We view these actions as material improvements toward strengthening the company's through-cycle return profile while allowing for more flexibility and dry powder to use its balance sheet to drive shareholder value. We've seen similar actions from a number of non-covered companies such as AWI/AFI, EXP, as well as many multi-industry companies which have completed or announced similar actions.

We've also seen a number of companies look to retrench and restructure in order to better optimize manufacturing footprints as market dynamics shift. DOOR, FBHS, JELD, MHK, and WHR are all executing actions to consolidate their respective footprints over the next few years. We anticipate that this is a trend that will continue and could be accelerated by productivity improvements generated by advancements in technology.

Technology expected to accelerate E&C industry consolidation

In light of industry fragmentation and limited pricing power, we expect a shift towards AI-based automation to put additional pressure on margins over time. We expect firms within the E&C sector to combat this reality by executing roll-up strategies or by shifting towards a more focused model that serves a specific niche or provides innovative services. Longer-term, we envision a scenario in which the E&C market begins to resemble the accounting landscape, which is dominated by the "Big 4" mega firms (i.e. KPMG, Deloitte, EY, and PWC) with smaller firms focusing on their immediate geographic markets and peripheral type assignments.

Appendix I: Disruptive Change Forces

Our iterative process synthesized a variety of inputs including RBC survey results, expert thinking, and primary and secondary research, boiling down hundreds of inputs to develop 23 Change Forces grouped under the broad categories of *Social, Technological, Environmental, Economic and Political*. While the accelerating pace of technological innovation from blockchain to bioengineering is an unavoidably dominant backdrop to this analysis, our work highlighted the necessity of contextualizing this with non-technological change forces such as the reemergence of populism, climate change and urbanization.

Exhibit 118: Change Force Tensions – Social

← SOCIAL CHANGE FORCE TENSIONS →		
Change Force	**Opportunities**	**Challenges**
A Changing Population	People will live longer, healthier lives.	Rapid population growth in developing countries creates pressure on resources.
Urbanization	Urbanization drives tech and social innovation, changing, cities into hyper-connected metropolitan centers.	Urbanization drives higher real estate prices, job competition, and pollution. Those in lowest income brackets increasingly marginalized.
Fluid Generation	Younger populations are more racially diverse, and more open- and globally-minded.	Younger generations demand values-driven business structures.
Rise of Women	Women will continue to enter and rise higher in the workforce, fueling economic growth.	Failures to change legacy workplace, social, and cultural barriers will hinder growth and ability to retain talent.
Changing Definition of Work & Working	The balance of power shifts from stability of employers to the unique skillsets and demands of the workforce	A shift in norms will require changes in corporate culture that current management may be uncomfortable with, leading to recruiting and retention issues.

Source: RBC Capital Markets

Exhibit 119: Change Force Tensions – Political

← POLITICAL CHANGE FORCE TENSIONS →		
Change Force	**Opportunities**	**Challenges**
Geopolitical Uncertainty	Governments lead with international collaboration to solve cross-border challenges, effectively bridge gaps and promote unity.	Fear and skepticism rise, increasing nationalist sentiments and further dividing nations.
Climate Change Policy	Nations enforce strict regulation and businesses innovate to find new, more efficient solutions.	Nations limit climate change regulation to reduce costs for their consumers and protect domestic industries.
Private Enterprising	Space innovation will be iterative with the presence of competition via private companies, leading to quick improvements and less time between trips and milestones.	Privatization will result in deregulation of the industry, allowing conflicting agendas to arise as programs are created to either explore or exploit space.

Source: RBC Capital Markets

Exhibit 120: Change Force Tensions – Technological

← TECHNOLOGICAL CHANGE FORCE TENSIONS →		
Change Force	**Opportunities**	**Challenges**
Big Data Gets Bigger, Faster	Big data helps personalize life, creating customized, tailored experiences, saving time and increasing efficiency.	If left unchecked, or in the wrong hands, we risk losing control of personal privacy and human empathy in the world's most important decisions.
AI & Cognitive Computing	Robotics become integrated into everyday life, improving collaboration and skillsets while minimizing the rate of human error.	Cognitive robotics outpace the need for human assistance and make human contributions obsolete.
Autonomous Cars	Automated transportation lowers costs overall, reduces accidents, and economizes the roads for everyone.	Car hacking becomes a real-life threat, and the world becomes reliant on a small number of companies to travel even short distances affordably.
Bioengineering	Widespread CRISPR applications in agriculture hold promise to improve yields and superior attributes.	Ethics of bioengineering will be questioned and challenged morally and legally.
Digital Engagement & Attention Economy	The online experience becomes more personalized as advertisers and other companies demand our attention.	The growing presence of second and third screens captivate attention more than the real world.
The New Reality	VR could revolutionize the way we learn, work, and spend our time with new potential to see the world (and beyond) without leaving the home.	With VR eliminating the need to travel, relationships with immediate family members, friends and colleagues risk becoming less personal leading to potential breakdowns in trust.
Cyber Security	Companies and online platforms will step up security measures, allowing customer data to flow freely between users, improving online experiences.	Continual high-tech hacking and security breaches leave millions vulnerable and distrustful.
Food & Agriculture Technology	Food production costs will decline dramatically as crop yields improve and technology becomes more efficient.	Bioengineered lab meat alternatives are deemed inferior to natural production.

Source: RBC Capital Markets

Exhibit 121: Change Force Tensions – Economic

← ECONOMIC CHANGE FORCE TENSIONS →		
Change Force	**Opportunities**	**Challenges**
Expanding E-Commerce	Consumers begin to satisfy all their retail shopping needs online and continue to marginalize excess retail space.	Online-only retailers acquire brick-and-mortar stores to augment brand experience.
Automation in the Workforce	Automation performs mundane tasks, freeing time to think creatively and solve problems computers cannot.	Massive job loss leads to increased unemployment and existential challenges for individuals and governments.
Protectionism Prevails	Governments and trade organizations work together to promote business and development.	Global commerce becomes restricted by protectionist policies and trade agreements begin to fail.

Source: RBC Capital Markets

Exhibit 122: Change Force Tensions – Environmental

← ENVIRONMENTAL CHANGE FORCE TENSIONS →		
Change Force	**Opportunities**	**Challenges**
New Resource Shortages	New innovations in desalination and vertical farming alleviate the increasing demand for natural resources.	Shortages in water cause it to become the new oil, starting a new arena of hydro-politics.
Energy Source Uncertainty	Advancements in renewable energies make them more efficient and affordable, sparking a new growth boom.	Economies stall as oil revenue decreases.
Climate Change	Mitigation and adaptation reduce the flow of heat-trapped greenhouse gases and adapting to life in changing climate while innovation and regulation find new solutions.	Severe weather events devastate and overwhelm societies unprepared and unable to prepare for them.
Evolution in Pollution	Innovation and new technologies drive efforts to clean up oceans and improve conservation of resources.	Toxic zones develop around the world, widening the gap between haves and have-nots.

Source: RBC Capital Markets

Contributing Authors

RBC Capital Markets, LLC

Mike Dahl (Analyst)	(212) 618-3251	michael.dahl@rbccm.com
Michael Eisen (Analyst)	(212) 905-5831	michael.eisen@rbccm.com
Ryan Frank (Associate)	(212) 548-3111	ryan.frank@rbccm.com
Lia Salmansohn (Associate)	(212) 558-0406	lia.salmansohn@rbc.com
Deane Dray (Analyst)	(212) 428-6465	deane.dray@rbccm.com
Andrew Krill (AVP)	(212) 301-1628	andrew.krill@rbccm.com
David Lu (AVP)	(212) 301-1631	david.lu@rbccm.com
Jeffrey Reive (Senior Associate)	(212) 618-3325	jeffrey.reive@rbc.com
Joseph Spak (Analyst)	(212) 428-2364	joseph.spak@rbccm.com
Garrett Klumpar (Associate)	(212) 428-6522	garrett.klumpar@rbccm.com
A.J. Ribakove (Associate)	(212) 428-3050	adam.ribakove@rbccm.com
Arun Viswanathan (Analyst)	(212) 301-1611	arun.viswanathan@rbccm.com
Alexander Yi (Associate)	(212) 658-6166	alexander.yi@rbccm.com
Seth Weber (Analyst)	(212) 618-7545	seth.weber@rbccm.com
Emily McLaughlin (AVP)	(212) 618-3280	emily.mclaughlin@rbc.com
Brendan Shea (Senior Associate)	(212) 301-1601	brendan.shea@rbccm.com

RBC Europe Limited

Damian Brewer (Analyst)	+44 20 7653 4900	damian.brewer@rbccm.com
Ruairi Cullinane (Analyst)	+44 20 7002 2275	ruairi.cullinane@rbccm.com
Mark Fielding (Analyst)	+44 20 7002 2128	mark.fielding@rbccm.com
Nick Housden (Analyst)	+44 20 7429 8831	nick.housden@rbccm.com
Sebastian Kuenne (Analyst)	+44 20 7429 8932	sebastian.kuenne@rbccm.com
Tom Narayan (Analyst)	+44 20 7429 8594	tom.narayan@rbccm.com
Wasi Rizvi (Analyst)	+44 20 7653 4591	wasi.rizvi@rbccm.com

Royal Bank of Canada - Hong Kong Branch

Stephanie D'Ath (Analyst)	+852 2848 1390	stephanie.dath@rbccm.com

RBC Dominion Securities Inc.

Paul C. Quinn (Analyst)	(604) 257-7048	paul.c.quinn@rbccm.com
Marcus Campeau (Associate)	(604) 257-7657	marcus.campeau@rbccm.com
Walter Spracklin (Analyst)	(416) 842-7877	walter.spracklin@rbccm.com
Alicia Buckiewicz (Associate)	(416) 842-8744	alicia.buckiewicz@rbccm.com
James McGarragle (Associate)	(416) 842-7862	james.mcgarragle@rbccm.com
Derek Spronck (Analyst)	(416) 842-7833	derek.spronck@rbccm.com
Kyle Brock (Associate)	(416) 842-8786	kyle.brock@rbccm.com
Ryall Stroud (Associate)	(416) 842-7876	ryall.stroud@rbccm.com

Companies Mentioned

3M Company (NYSE: MMM US; $160.07; Sector Perform)
ABB Ltd (SWX: ABBN SW; CHF18.63; Sector Perform)
AB Volvo (STO: VOLVB SS; SEK135.55; Sector Perform)
Adecco Group AG (SWX: ADEN SW; CHF52.90; Outperform)
Adient Public Limited Company (NYSE: ADNT US; $21.05; Sector Perform)
AGCO Corporation (NYSE: AGCO US; $68.73; Outperform)
Air Canada (TSX: AC CN; C$43.57; Outperform)
Albemarle Corporation (NYSE: ALB US; $61.31; Outperform)
Alphabet Inc. (NASDAQ: GOOGL US; $1,182.27; Outperform)
Amazon.com, Inc. (NASDAQ: AMZN US; $1,800.62; Outperform)
Aptiv PLC (NYSE: APTV US; $84.19; Outperform)
AquaVenture Holdings Limited (NYSE: WAAS US; $17.50; Outperform)
Ardagh Group S.A. (NYSE: ARD US; $17.08; Outperform)
ASGN Incorporated (NYSE: ASGN US; $62.83; Outperform)
AT&T Inc. (NYSE: T US; $35.72; Sector Perform)
Atlas Copco AB (STO: ATCOA SS; SEK295.40; Top Pick)
Axalta Coating Systems Ltd. (NYSE: AXTA US; $29.01; Outperform)
Ball Corporation (NYSE: BLL US; $80.78; Outperform)
Bayerische Motoren Werke Aktiengesellschaft (XETRA: BMW GR; €61.09; Sector Perform)
BMC Stock Holdings, Inc. (NASDAQ: BMCH US; $25.04; Sector Perform)
Bodycote plc (LSE: BOY LN; GBp710.50; Outperform)
BorgWarner Inc. (NYSE: BWA US; $33.21; Sector Perform)
Builders FirstSource, Inc. (NASDAQ: BLDR US; $19.06; Sector Perform)
Canadian National Railway Company (TSX: CNR CN; C$121.20; Sector Perform)
Canadian Pacific Railway Limited (TSX: CP CN; C$313.97; Outperform)
Carlsberg A/S (CSE: CARLB DC; DKK1,024.00; Outperform)
Cascades Inc. (TSX: CAS CN; C$11.43; Outperform)
Cisco Systems, Inc. (NASDAQ: CSCO US; $47.32; Outperform)
Coats Group PLC (LSE: COA LN; GBp72.50; Outperform)
Crown Holdings, Inc. (NYSE: CCK US; $66.05; Outperform)
CSX Corporation (NASDAQ: CSX US; $67.50; Sector Perform)
Daimler AG (XETRA: DAI GR; €44.02; Outperform)
Dana Incorporated (NYSE: DAN US; $12.78; Outperform)
Danaher Corporation (NYSE: DHR US; $140.26; Sector Perform)
Danone (NXT PA: BN FP; €82.00; Outperform)
Deere & Company (NYSE: DE US; $151.72; Outperform)
Domino's Pizza Group Plc (LSE: DOM LN; GBp239.90; Outperform)
Dover Corporation (NYSE: DOV US; $93.25; Sector Perform)
Dow Inc (NYSE: DOW US; $42.54; Outperform)
easyJet PLC (LSE: EZJ LN; GBp928.00; Outperform)
Emerson Electric Co. (NYSE: EMR US; $59.61; Sector Perform)
Evoqua Water Technologies Corp. (NYSE: AQUA US; $15.60; Outperform)
Exxon Mobil Corporation (NYSE: XOM US; $69.29; Sector Perform)
Faurecia (NXT PA: EO FP; €42.12; Underperform)
Flowserve Corporation (NYSE: FLS US; $41.99; Sector Perform)
Ford Motor Company (NYSE: F US; $9.20; Sector Perform)
Fortive Corporation (NYSE: FTV US; $66.96; Sector Perform)

Fortune Brands Home & Security, Inc. (NYSE: FBHS US; $49.91; Outperform)
Garrett Motion Inc (NYSE: GTX US; $10.00; Sector Perform)
General Electric Company (NYSE: GE US; $8.80; Outperform)
General Motors Company (NYSE: GM US; $38.24; Outperform)
HD Supply Holdings, Inc. (NASDAQ: HDS US; $39.19; Sector Perform)
Hexagon AB (STO: HEXAB SS; SEK434.20; Outperform)
Honeywell International Inc. (NYSE: HON US; $167.14; Outperform)
IMI plc (LSE: IMI LN; GBp996.40; Sector Perform)
Intel Corporation (NASDAQ: INTC US; $48.92; Underperform)
International Consolidated Airlines Group S.A. (LSE: IAG LN; GBp424.20; Outperform)
International Paper Company (NYSE: IP US; $38.66; Sector Perform)
IPL Plastics Inc. (TSX: IPLP CN; C$8.96; Outperform)
JELD-WEN Holding, Inc. (NYSE: JELD US; $16.73; Sector Perform)
KB Home (NYSE: KBH US; $28.69; Outperform)
Lear Corporation (NYSE: LEA US; $113.33; Sector Perform)
Louisiana-Pacific Corporation (NYSE: LPX US; $23.22; Top Pick)
Lowe's Companies, Inc. (NYSE: LOW US; $111.92; Outperform)
Lyft, Inc. (NASDAQ: LYFT US; $46.35; Outperform)
LyondellBasell Industries N.V. (NYSE: LYB US; $75.82; Outperform)
ManpowerGroup Inc. (NYSE: MAN US; $81.12; Outperform)
Masco Corporation (NYSE: MAS US; $40.66; Outperform)
Masonite International Corporation (NYSE: DOOR US; $52.44; Outperform)
Mercer International Inc. (NASDAQ: MERC US; $11.94; Sector Perform)
Mohawk Industries, Inc. (NYSE: MHK US; $115.01; Underperform)
Nestle S.A. (SWX: NESN SW; CHF112.00; Sector Perform)
Norbord Inc. (TSX: OSB CN; C$30.91; Outperform)
Norfolk Southern Corporation (NYSE: NSC US; $171.57; Underperform)
NVIDIA Corporation (NASDAQ: NVDA US; $168.76; Outperform)
OC Oerlikon Corporation AG (SWX: OERL SE; CHF9.11; Sector Perform)
Oracle Corporation (NYSE: ORCL US; $52.97; Sector Perform)
Owens Corning (NYSE: OC US; $55.74; Outperform)
Pentair Public Limited Company (NYSE: PNR US; $35.50; Sector Perform)
PepsiCo, Inc. (NASDAQ: PEP US; $139.15; Sector Perform)
Peugeot SA (NXT PA: UG FP; €20.71; Underperform)
PPG Industries, Inc. (NYSE: PPG US; $111.52; Outperform)
Randstad NV (NXT AM: RAND NA; €43.20; Outperform)
Rayonier Advanced Materials Inc. (NYSE: RYAM US; $3.48; Outperform)
Redfin Corp (NASDAQ: RDFN US; $16.24; Outperform)
Renault (NXT PA: RNO FP; €53.70; Top Pick)
Republic Services, Inc. (NYSE: RSG US; $89.83; Sector Perform)
Robert Half International Inc. (NYSE: RHI US; $52.90; Sector Perform)
Roper Technologies, Inc. (NYSE: ROP US; $368.80; Outperform)
Rotork P.L.C. (LSE: ROR LN; GBp314.90; Outperform)
Schneider Electric SE (NXT PA: SU FP; €74.74; Outperform)
Sealed Air Corporation (NYSE: SEE US; $39.60; Sector Perform)
SIEMENS AG (XETRA: SIE GR; €91.71; Sector Perform)
Skyline Champion Corporation (NYSE: SKY US; $28.10; Outperform)
SNC-Lavalin Group Inc. (TSX: SNC CN; C$15.50; Outperform)
Spirax-Sarco Engineering plc (LSE: SPX LN; GBp8,025.00; Underperform)

SPX FLOW, Inc. (NYSE: FLOW US; $33.25; Underperform)
Stantec Inc. (TSX: STN CN; C$28.75; Sector Perform)
Tesla, Inc. (NASDAQ: TSLA US; $220.68; Underperform)
The Sherwin-Williams Company (NYSE: SHW US; $534.67; Outperform)
Toll Brothers, Inc. (NYSE: TOL US; $36.62; Sector Perform)
Uber Technologies Inc (NYSE: UBER US; $31.99; Outperform)
Union Pacific Corporation (NYSE: UNP US; $160.08; Outperform)
Veoneer, Inc. (NYSE: VNE US; $14.18; Sector Perform)
Visteon Corporation (NASDAQ: VC US; $69.84; Sector Perform)
Volkswagen AG (XETRA: VOW3 GR; €148.04; Outperform)
W.W. Grainger, Inc. (NYSE: GWW US; $268.17; Underperform)
Walmart Inc. (NYSE: WMT US; $115.91; Sector Perform)
Waste Management, Inc. (NYSE: WM US; $120.65; Outperform)
WESCO International, Inc. (NYSE: WCC US; $44.22; Sector Perform)
Westrock Company (NYSE: WRK US; $33.99; Sector Perform)
Whirlpool Corporation (NYSE: WHR US; $137.68; Underperform)
WSP Global Inc. (TSX: WSP CN; C$70.68; Outperform)
Xylem Inc. (NYSE: XYL US; $75.31; Outperform)
Zillow Group, Inc. (NASDAQ: ZG US; $32.23; Sector Perform)

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