



TRANSPORT & LOGISTICS

2016

Digital Industry: Taking Rail Virtual
Uber-Trucking Is on Its Way
Speeding Up Aerospace Innovation
Reinventing Online Travel Booking
And more...

TO OUR READERS

WELCOME TO THE 2016 EDITION of Oliver Wyman's *Transport & Logistics* journal. In this issue, we explore the complex and unprecedented changes occurring in technology, markets, and society that are challenging companies across the transportation, logistics, and travel sectors.

Many of these changes are encapsulated in the idea of the fourth industrial revolution – a paradigm shift that will fuse together an array of evolving technologies, thereby ushering in new levels of connectedness, automation, and transparency. No industry will escape the business implications of a digitalizing culture and economy. Operations and assets will continue to get smarter, while simultaneously delivering a river of sensor-based data that will require much more sophisticated analytical tools. At the same time, changes in consumer culture – from e-commerce expansion to mobile app-based everything and crowdsourcing – will increasingly guide the choices companies make as they seek new avenues of growth.

The Internet of Things, artificial intelligence, big data, additive manufacturing, the sharing economy, radical shifts in e-commerce and energy: It's a lot to take in. The brief articles that follow are designed to be a starting point for consideration and discussion of what the next ten years might hold for transportation-related industries – both in terms of these global trends and changes specific to each industry. Passenger railroads face new competition from buses. Freight railroads are dealing with the fallout of energy transition. Airlines and airports are being impacted by changing aircraft technology and traveler tastes. Trucking is about to step into a new realm of digital solutions for longstanding efficiency and labor issues. Nevertheless, across industries, the backbone demands of operational excellence, customer service, reliability, and cost control will continue to be as vital as ever.

We hope that you find this issue of the *Transport & Logistics* journal to be a thought-provoking read, and we look forward to hearing your comments.

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Innovations



TAKING RAIL VIRTUAL THROUGH DIGITAL INDUSTRY

THE STEAM POWER of the first industrial revolution ushered in the first great age of the railways. The second – electric power – saw steam replaced by diesel, and the third – which included the birth of information and communication technologies – gave rise to the modern and efficient rail systems of today. Now the world is entering a fourth such revolution, which, in the words of the World Economic Forum, will be “characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres.” Some of the boundary-crossing technologies of what is variously called “industry 4.0” or “digital industry” include cyber-physical systems, the

Internet of Things, and new applications such as additive manufacturing (3D printing) and autonomous vehicles.

For rail and other transportation industries, the fourth industrial revolution promises continuing acceleration of innovation on both the supply and demand side. From the manufacture of rolling stock to how rail operators serve their customers, new technologies will lead to entirely new ways of doing business.

Disruption of value chains will reach unprecedented levels as well, driven not by a few proprietary standard setters (e.g., Microsoft, Oracle), but will bubble up from the most agile and innovative in an interconnected world of “makers” as well as consumers. As an example,

Deutsche Bahn has initiated a series of “Deutsche Bahn Goes 4.0” hackathons, in which anyone can participate to develop ground-breaking solutions to specific challenges, such as predicting track position defects or improving information desk services.

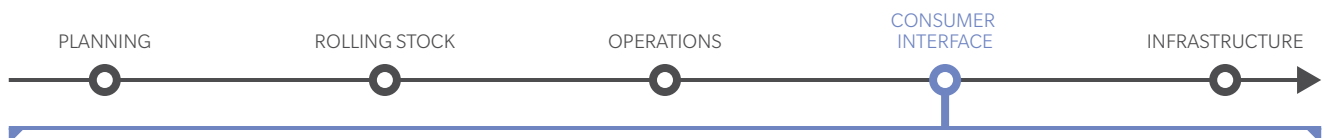
DIGITALIZING RAIL SUPPLY

Digital industry will support new applications and business models for manufacturing and disrupt all phases of the supply chain. The product development process will become fully digitalized, making it faster and more flexible. Railroads and their suppliers, working together, will be able to use real-time data, digital models, and virtual tooling

and testing environments to reduce time and cost for the development of smarter and more sustainable trains. Standardization and modularization will be implementable even in complex environments. In addition, streaming data from rolling stock in operation will feed back to improve the design and build process, as well as enabling better predictive maintenance.

Longer term, one might see rail suppliers become primarily product designers, outsourcing to “smart factories” that produce modular components – often 3D printed. While digital industry offers the potential for much greater customization, to take full advantage, the industry will need to work closely with certifying bodies and regulators to streamline currently complex approval and certification processes.

DIGITALIZATION OPPORTUNITIES IN THE PASSENGER RAIL VALUE CHAIN – CONSUMER INTERFACE EXAMPLE



CLUSTER	BENEFITS FOR PASSENGERS	EXAMPLES OF OFFERS NOT YET ESTABLISHED	ACTIVE EXAMPLES
Integrated tools for planning	<ul style="list-style-type: none"> • Simplicity • Information 	<ul style="list-style-type: none"> • Cross-transportation mode planning tool • Mobility check – identification of “sturdy” connections • Commuter advisory, including traffic forecasts 	<ul style="list-style-type: none"> Kayak Tripit Google
Information bundles complementing the journey	<ul style="list-style-type: none"> • Information • Improved comfort • Personalization 	<ul style="list-style-type: none"> • Up-to-date news about the weather, events, activities at the destination • Point of interest finder (museums, tours, etc.) • Orientation and navigation for boarding, changing, and alighting 	<ul style="list-style-type: none"> TripAdvisor Gate Guru Flight View HRS
Service and comfort	<ul style="list-style-type: none"> • Information • Improved comfort • Personalization 	<ul style="list-style-type: none"> • Alarm/reminder SMS prior to departure (based on current traffic situation) • Dining offers • Parking spot finder • Car sharing 	<ul style="list-style-type: none"> Groupon Car2Go DriveNow BlablaCar Apple
Social factors and entertainment	<ul style="list-style-type: none"> • Improved comfort 	<ul style="list-style-type: none"> • Overview of friends’ journeys/follow commuters • “Friend finder” and chat • Games and audiobooks for children 	<ul style="list-style-type: none"> Audible TripTrace Facebook

Source Oliver Wyman

SMARTER OPERATIONS AND INTERFACES

In the future, railroads also will leverage fourth revolution technologies to improve operations. For example, big data analytical techniques could increase train punctuality, by better predicting and eliminating sources of service disruption. Smart planning and dispatching networks will significantly reduce system costs, as will trains that are autonomous or boast increased artificial intelligence. Robotization of intermodal terminals and yards might make use of technologies similar to those now in use at advanced ports, such as the Port of Hamburg.

Rail can be expected to play an important role in next-generation mobility, which will be increasingly characterized by a desire for access rather than ownership, technology-enabled transparency, two-way communication, and shared consumption.

On the freight side, products themselves will increasingly be direct users of the Internet; connected railcars and containers will provide their own streaming updates on location, condition, and itinerary. Longer term, autonomous cars and trucks will communicate directly with dispatch centers, terminals, and even trains, ensuring their passengers and cargos are at the right place at exactly the right time.

In passenger transport, digitalization will improve ticket changing and pricing, and make access for customers easier. Most major rail companies are pushing mobile ticketing solutions; this will be especially good for customers if simpler or best-price fare systems are introduced in those countries that now have complex tariff systems. (Ideally combined with automated passenger detection systems for coaches, so that separate ticket validation processes are unnecessary.)

Further improvements can be expected in customer feedback management. Current processes are extremely slow, inefficient, and not customer-oriented. Through better use of social media and feedback platforms, rail operators will achieve real-time,

streaming communication with their customers. Travelers will be able to immediately report train problems, and in turn operators will be able to fix defects faster and notify customers right away when problems are solved.

RUNNING ON DIGITAL

Companies are already beginning to see incremental benefits from this fourth revolution. Long-term substantive benefits will be more challenging, requiring a new level of coordination between transportation suppliers and operators, and the willingness to embrace transformation that goes beyond information technology to the continuous revamping of organizational functions and activities as new game-changing innovations emerge.

Ultimately, the rules of business will be different, governed by a paradigm of being sharable, accessible, reliable, and able to perform at marginal cost. Companies will need to be both integrated and decentralized (“glocal”), and engage both their suppliers and customers more broadly and deeply. Railroads have a long history as networked businesses; the fourth industrial revolution will extend those networks in ways that we are only beginning to comprehend.

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HIT BY A BUS: EUROPEAN PASSENGER RAIL

WESTERN EUROPE IS in the midst of a sweeping deregulation of intercity motor coach markets – Sweden, Finland, Germany, Italy, and France have all recently opened these services to competition. The result is a new class of low-cost competitors that are putting pressure on long-distance passenger rail services and rapidly gaining market share. Rail operators will need to move quickly to counter this existential threat.

HERE COMES THE BUS

The intercity buses of today offer train-like comforts (such as luxury seats, restrooms, wi-fi, snacks, and beverages) but at a fraction of the price of rail on high-density routes. We

believe that new bus operators have lured up to 20 percent of customers away from some rail services in just a couple of years, thanks to aggressive marketing tactics, a smart route network, and large seating capacities.

Consider the popular Hamburg-Berlin route. Rail service is more frequent and faster, but bus fares are much less. The rail operator does offer some deeply discounted tickets at \$20, but that's still, on average, twice the price of the lowest-cost bus ticket. And aggressive bus companies are slicing fares even more on routes where they compete with rail.

By offering comparable or even better quality service, bus operators are attracting middle-income passengers and business

customers. This is especially true for routes between cities that are poorly served by train (low speeds, limited frequencies, or limited on-board comfort).

As a result, two competitive scenarios are emerging for passenger rail: On routes operated with very high-speed trains (300 kmh versus 100 kmh for bus), rail operators will continue to benefit from their huge travel time advantage. Rail companies also can deploy economic models to help limit their market share erosion on such routes, such as a low-fare offering from France's SNCF called OUIGO. But on traditional rail routes with lower speeds and a less modern fleet (meaning buses can compete head on), market share erosion for rail operators is just beginning.

UPPING RAIL'S APPEAL

We recently surveyed European travelers and found that while rail still clearly wins on comfort and enjoyment (for now), travelers consider bus a better value. Buses also win in areas where rail ought to have the advantage, such as innovation and service orientation. Attempts by rail companies to retain customers with isolated price reductions and promotions have had a limited impact on market share erosion thus far and are unlikely to be successful over the long term.

Bus fleets are structurally much cheaper and more flexible to operate than trains, so rail operators won't be successful competing purely on price. Instead, they will need to figure out how to best capitalize on their strengths: national and dense networks, strong brands, loyal customer bases, committed staff, and well-appointed stations.

A comparable lesson is the emergence of low-cost airlines in the 1990s, which traditional European airlines didn't immediately perceive as a paradigm shift. The new entrants offered lower prices, but they also operated in ways that changed customers' expectations and behaviors. Several traditional airlines foundered when they were unable to learn from these up-and-comers and adapt.

Passenger rail services in bus-competitive lanes now face the same peril if they fail to rethink their product and service offerings and adapt their business designs. Fending off market share erosion will require not only

Comparison of rail and bus services for Hamburg-Berlin

	RAIL	BUS
Frequency	Every 30 minutes	Every 75 minutes
Journey time	1 hour and 38 minutes	3 hours
One-way fare	\$42-\$85, limited discount prices from \$20 and up	\$8-\$18

lower prices, but innovation – improving the entire door-to-door mobility chain in terms of transparency, ease of use, and interconnectedness – and aligning product offerings with what customers are willing to pay. In some cases, rail operators may need to adjust capacity while refocusing investments on enriched offerings. Stations also could be utilized to profit from evolving generational changes, such as charging stations for e-cars, upgraded work and play/rest areas, even drop-in “maker spaces.”

Finally, rail operators may want to consider diversifying, by taking a position in the low-cost intercity bus market themselves. Some already have: German railway Deutsche Bahn runs a low-cost luxury bus service on routes to/from Germany that are not well served by trains. A rail operator already possesses

the core competencies necessary to operate buses and could even use its data on customer journeys and travel preferences to build targeted bus and linked rail-bus offers.

THE TIP OF THE ICEBERG

Passenger railroads are facing an uncertain future as part of a broadening and diversifying mobility market that includes not only new bus services but also car sharing, integrated mobility solutions, and autonomous cars. Understanding these trends, anticipating their associated risks and opportunities, and being willing to adapt flexibly and rapidly can ensure rail operators make good investment decisions and maintain a strong position in this market.

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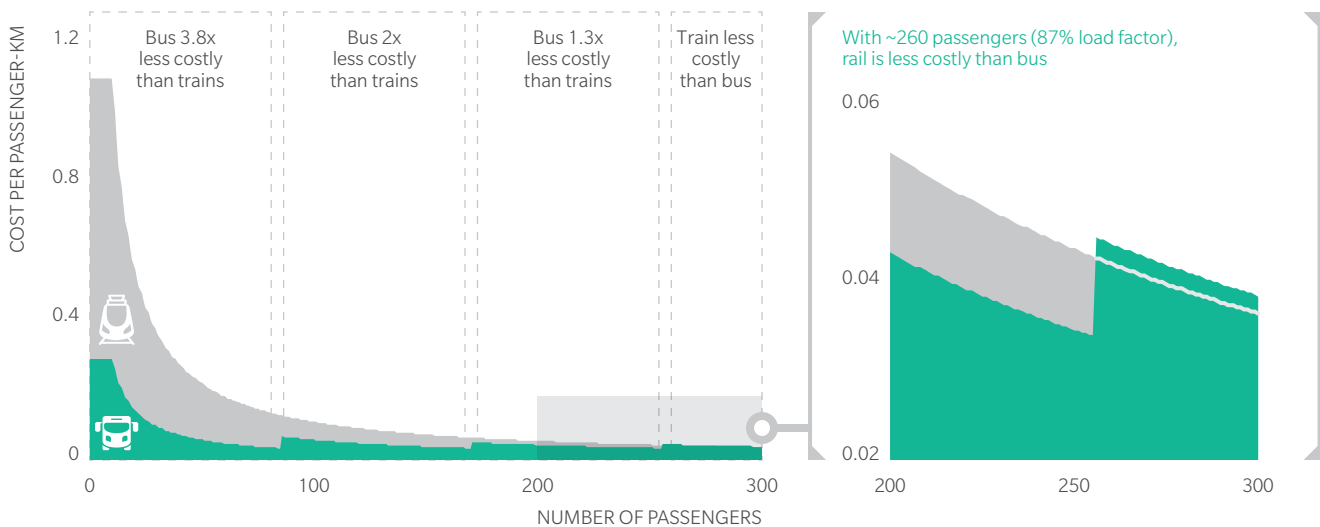
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EUROPEAN INTERCITY PASSENGER BUS VERSUS RAIL COST STRUCTURE



Note Assumes double-decker with 85 seats, \$3.26 per bus-km; train with 300 seats, \$12.38 per train-km
Source Oliver Wyman analysis



THE ANCILLARIES CHALLENGE IN ONLINE TRAVEL BOOKING

THE TRAVEL “BOOKING JOURNEY” has many stages – from the first dream of a destination to the last photo shared on Facebook. And where once interaction with a travel agent might have been limited to booking a ticket and a room, consumers now expect a wide range of travel services and products to be on offer at every stage of the booking journey. These “ancillaries,” as they are known in the industry, are an important revenue stream for both travel suppliers, such as airlines and hotels, and travel retailers, such as online travel agents (OTAs).

Ancillaries come in two flavors: *unbundled*, which refers to add-ons that were previously included in a core product offering (such as baggage and in-flight meals for airlines), and *incremental or trip-related* products, such as ground transportation, activities and tours, and insurance. Ancillaries currently account for a relatively small share of total revenues for airline and hotel brands. (For example, ancillaries accounted

for only about 8 percent of total US airline revenues in 2015.) There is broad consensus, however, that ancillaries could reach \$180 billion globally by 2020. It’s an enticing future market that traditional travel suppliers are not doing nearly enough to win.

DIVING INTO THE BOOKING JOURNEY

Online shopping, smartphones, and social media have conditioned consumers with limited time to bookmark websites and download apps that provide quick, simple solutions. This trend will only grow, given that global Internet and smartphone penetration are expected to reach 80 percent by 2025. In the travel arena, this means that consumers are gravitating to “one-stop shops” that are perceived to offer good value for money, along with up-to-date information and a frustration-free booking experience. The result is that OTAs such as Expedia and

Priceline have taken a significant chunk of direct travel bookings (and margin) from travel suppliers.

OTAs allow customers to build comprehensive and tailored travel packages, including a wide range of trip-related ancillary products from a variety of suppliers. Many hotels and airlines have developed effective online booking flows for their core seat or room products and unbundled ancillaries. But they are not taking full advantage of the opportunity presented by trip-related ancillaries – which could lead to their falling further behind OTAs in terms of customer appeal.

Many airlines and hotels also have built only limited ancillary merchandising capabilities, focusing heavily on the booking stage of the customer journey. OTAs, on the other hand, are investing heavily to capture ancillary sales end-to-end. They inspire whole-trip ideas, seamlessly market targeted ancillary products between the booking and traveling steps, and integrate customer review and rating systems and social media links.

Travel suppliers' immediate tactical response has been to offer benefits such as free wireless and loyalty points for direct bookings. This clearly is insufficient, as evidenced by the continued slide in direct channel bookings. Unless they dig deeper, airlines and hotels risk becoming simple commodity suppliers to OTAs.

GOING THE DISTANCE ON ANCILLARIES

To regain their competitiveness in relation to OTAs, travel suppliers will need to consider a number of strategies to improve their direct channel offerings and enhance their appeal to customers.

Direct Booking Enticements

Airlines and hotels need to give customers a reason to book directly with them. This could include capitalizing on their core inventory to offer unique unbundled ancillary products, such as the ability to choose a specific

hotel room, combined with trip-related ancillaries like access to an exclusive supplier or product.

Travel suppliers also must streamline and innovate the booking process. Ancillary sales are often an afterthought on most suppliers' websites, requiring lots of clicks, separate booking transactions, and the rekeying of data. Suppliers must integrate ancillaries into the core booking flow and design "omnichannel" processes that allow customers to seamlessly transition across multiple platforms and engage social media as well.

Increasing Customer Engagement

Ancillaries play a critical role in customer engagement by offering choices and simplifying hassles. Airlines and hotels could capture data from their direct booking channels to develop a deeper understanding of individual customer preferences, so that they can better personalize the end-to-end booking journey and present tailored ancillary propositions at personalized price points. These insights also could be used to fuel novel post-booking interactions that reinforce customer engagement, such as a targeted reminder to buy trip insurance or free downloadable apps that offer destination updates and reviews.

Strengthening the Value of Loyalty

Customer loyalty and the likelihood of rebooking can be strengthened through better use of ancillaries. Customer insights, for example, can be used to generate exclusive, tailored offers of complimentary or reduced price ancillaries for those who book through a travel supplier's direct channels. Hotel operators in particular are increasingly making use of loyalty member "treats" like free airport transfers and reduced-price breakfasts.

Focusing on Execution

Finally, if travel suppliers are to succeed in attracting customers to their channels and growing ancillary revenues, they must build out their execution

THE CUSTOMER BOOKING JOURNEY AND EXAMPLE ANCILLARY ENGAGEMENT OPPORTUNITIES



COMPARISON OF INCREMENTAL ANCILLARY BOOKING OFFERS

	FLIGHT	HOTEL	CAR RENTAL	TOURS AND ACTIVITIES	INSURANCE
Leading online travel agency (OTA) <ul style="list-style-type: none"> Fully integrated booking flow for incremental ancillaries Broad product range 	●	●	●	●	●
Major full-service airline <ul style="list-style-type: none"> Incremental ancillaries typically offered through separate booking flow and white label solutions 	●	●	●	●	●
Major hotel company <ul style="list-style-type: none"> Booking flow focused on hotel room sales Strong opportunity to expand incremental ancillaries offering 	●	●	●	●	●

● Core travel offering ● Current ancillary space ● Potential ancillary space

Note Example search for SFO to NYC for two people from 6-Feb-2016 to 13-Feb-2016: Flight + hotel + car
Source Company websites

tool kit. This means acquiring the right capabilities, assigning the strongest teams to deliver on ancillaries, and increasing their appeal as go-to booking sites.

Through exclusive partnership arrangements with highly rated brands, travel suppliers can develop a catalog of potentially unique incremental ancillary products. They should consider information technology partnerships to close execution gaps and test minimum viable products without waiting for the “perfect” technology. Most important, they must develop the big data analytics required to mine and then translate customer data insights into a seamless, personalized customer experience across the travel cycle.

THE JOURNEY IS THE DESTINATION

Clearly, travel suppliers need to invest more in ancillaries, not only to deliver additional high-margin revenue, but

also to reduce third-party distribution costs across the travel supply chain and avoid commodity status. They might do well to take a page from the e-commerce retail giants: By building a comprehensive and constantly innovating range of products, services, and experiences, they can increase their appeal to contemporary travelers and build lasting customer relationships.

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A WHIRLWIND OF CHANGE FOR POSTAL SERVICES

POSTAL SERVICES TODAY operate in markets that are changing at an ever-increasing pace. They may feel as if a house had fallen on them, given declining letter volumes, deregulation of markets, increased competition, and an explosion of business-to-consumer parcel volumes. But there are more changes yet to come that will radically impact postal services around the world and create a strange new landscape that they must learn to navigate. Choosing the right road will lead to relevancy and profits; choosing the wrong one will lead to disintermediation and decline.

LETTERS AND PACKAGES, OH MY

The story for mail and parcel volumes is one of continuing divergence: We now expect mail volumes to decline through 2025 before leveling off. Parcel volumes will continue to increase; our market model for the US and Europe forecasts that by 2025, online purchases could account for 60 percent of all parcel-size goods and non-grocery purchases. Even still largely offline businesses like fresh/grocery could see online penetration of 25-30 percent.

For postal services, these additional parcel volumes are not an automatic “get,”

however. In many countries, large integrators, such as UPS, FedEx, and DHL, as well as regional firms, have ruthlessly optimized express and parcel products and continue to push the innovation envelope.

On the other side of the market, major e-commerce companies, as part of their never-ending hunt for differentiation and customer convenience, are making increasing demands for service improvement and pushing down prices. Further complicating the picture is that Amazon is becoming a true end-to-end logistics player and has already targeted the most profitable element of parcel services – urban deliveries – through acquisitions, its own delivery logistics services, and Uber-like programs (AmazonFlex).

BEHIND THE CURTAIN

We believe that three major innovations have the power to completely change the postal industry’s structure: Crowdsourced delivery, autonomous vehicles, and drones. By untangling network economics, these innovations could alter the cost structure of parcel delivery, giving less weight to density, drop factors, and ultimately the utilization of large fixed assets, in

favor of smaller, more flexible assets. As these structures evolve, the traditional advantages of incumbents will become less important.

Most critically, large online companies continue to roll out new solutions across multiple countries with ease, while many postal and express parcel firms find themselves continuously playing catch-up and are often limited to national solutions. They also in some cases must deal with regulatory requirements and bureaucratic and political hurdles that are making it difficult for them to invest and change faster. Clearly, postal services will need to get better at innovating from an end-customer perspective and behave more like their new competition.

NOT IN KANSAS ANYMORE

Traditionally, postal services and parcel companies worried mainly about costs and often engineered solutions from this perspective; cost concerns thus drove “old innovation.” But new forces are setting the pace now:

End customers are convenience driven, which means that “new innovation” must focus to a much greater extent on removing existing customer hassles, even

to the point of creating convenience where the customer does not yet expect it.

Combining technology solutions has become the enabler of customer convenience. Customers expect to be able to route parcels to where and when they want them, and track the process every step of the way in real time. Technology means that parcels can meet consumers, while platforms linked to operations are enabling crowdsourced delivery and curbside pickup services.

The retailer mindset and focus are changing. Online and omnichannel retailers have increasing expectations when it comes to the quality of delivery and return services. Securing a trusted one-stop logistics chain has become vital even for non-traditional and niche retail platforms like Ebay, Google, and others. In these cases, postal and express parcel networks become a valuable asset, one that cannot (yet) be duplicated by software engineers in Silicon Valley.

THE YELLOW BRICK ROAD

We believe that there are a number of high-caliber options for postal services

to remain relevant and competitive, but given the rapid pace of change, options will not remain open for long. Specific opportunities will depend on each postal service's unique situation within its geography, regulatory regime, and decision-making culture. As well, understanding end customers, technology, and the retailer mindset will be critical.

The base for letter mail in most OECD countries is still enormous – and letter mail likely will still be 30-40 percent of revenues ten years out. In response, postal companies will need to develop more flexible cost structures, while leveraging their networks and new technology (just as on the parcel side). There is certainly plenty of room to innovate: On the one hand, reducing physical service levels as mail volumes fall can reduce costs (examples: Canada and Italy). On the other, adding customer friendly hybrid solutions, such as daily digital plus on-demand physical delivery, can increase revenues.

On the parcel side, competing effectively will require continuous focus on understanding customer hassles better than Amazon and where customers are willing to pay to reduce those hassles. Cost

management and operational excellence will be underlying requirements, rather than differentiating factors. Strategic partnering and favorable e-commerce contracts will be important to bring innovations to the table and secure the postal service role in the logistics chain.

And let us not forget that some of the largest e-commerce companies and consumer goods manufacturers globally, like Alibaba, are eagerly looking from Asia toward European and US markets, seeking distribution (and possibly one-stop-shopping) partnerships. That alone is a whole new game and could lead to a new industry structure. Unlike Dorothy in the *Wizard of Oz*, postal services can't go home again. They do have a future, but it's one they must create for themselves.

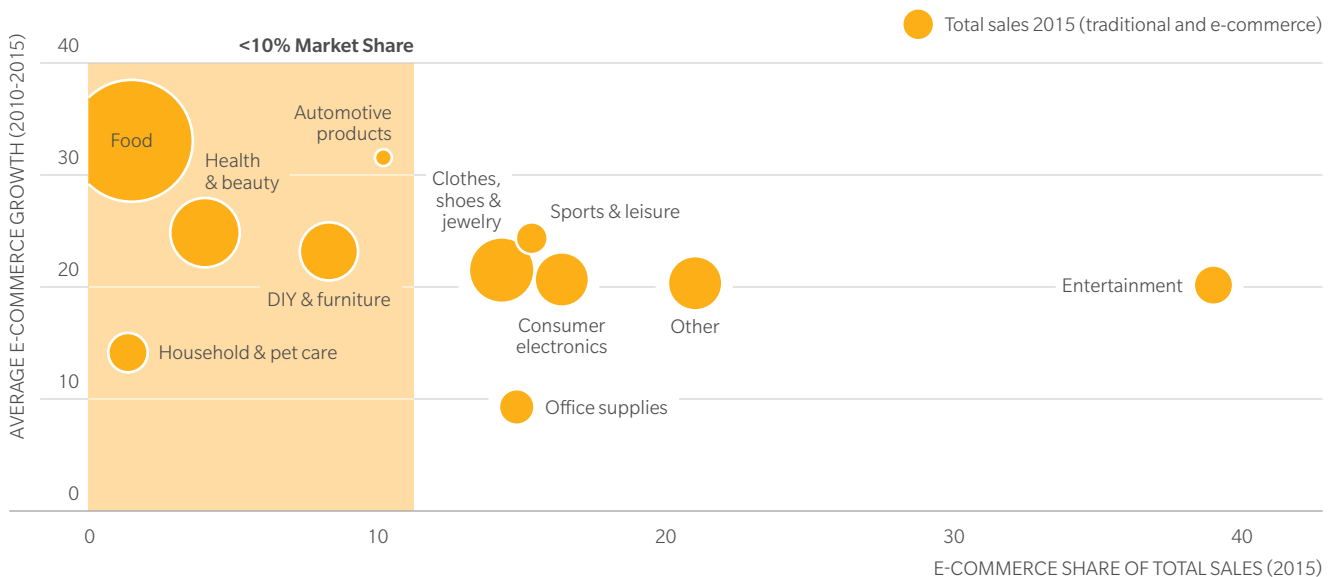
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MATURITY OF E-COMMERCE MARKET SECTORS
US, GERMANY, FRANCE, GREAT BRITAIN



Source Planet Retail, Oliver Wyman analysis



UBER-TRUCKING IS ON ITS WAY

MOBILE APPLICATION-BASED ride sharing services such as Uber and Lyft have been around only a few years, but they have revolutionized the urban taxi landscape. Ride sharing has emerged as an attractive alternative because of the way it solves so many “getting from here to there” hassles: instant location of a driver or rider, pricing and payment taken care of in the app itself, pre-planned route navigation, and ratings by both parties to keep the risk of problems low.

Now the idea of doing something similar for truckload and less-than-truckload freight is catching fire. At least a dozen companies are in the hunt to develop and promote “smart trucking” apps that provide an all-in-one solution for shippers and carriers of non-contract freight: fast, automated load matching based on location and equipment; turn-by-turn route planning and shipment tracking; algorithm-based instant pricing; and seamless proof-of-delivery, billing, and payment. Such Uber-style apps are looking to displace closed, fragmented, and time-consuming legacy systems:

load matching via online/truck stop load boards and calls to freight brokers, and documentation using electronic data interchange (EDI).

Many of the new trucking apps are being developed by non-traditional technology companies with brokerage authority, and these are looking to increase their appeal by undercutting the middleman fees charged by traditional freight brokers, while offering more comprehensive solutions. Thus much like the taxi industry, which is now fighting back against ride sharing with its own streamlined apps (such as Hailo and Arro), traditional truck freight brokers will need to embrace “uberization” as well – or risk being displaced entirely.

CARRIER AND SHIPPER BENEFITS

The transformative power of smart trucking apps could be vast: On the carrier side, benefits could include lower operating costs, increased loaded miles, higher

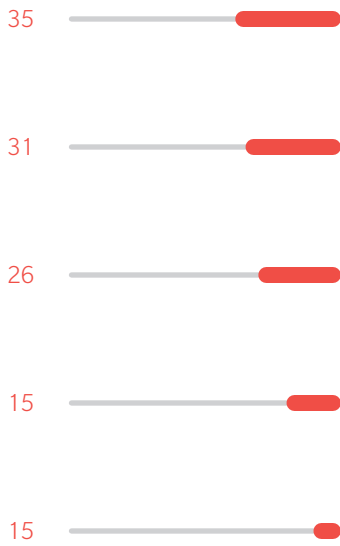
revenues (due to reduced brokerage fees), and better fuel efficiency and asset utilization. More than 90 percent of US trucking companies operate six or fewer units, and these small truckers are likely to benefit the most. All-in-one apps could level the playing field with larger trucking companies by providing mom-and-pops with better routing decisions and fuel prices, low-cost GPS tracking, and the ability to boost their market appeal through customer ratings and reviews.

On the shipper side, larger app-based marketplaces should give small shippers more access to ready capacity, at price points that they can more easily control. Large shippers, on the other hand, should be better able to manage exception freight that falls outside of their typical contract agreements, such as freight surges prior to holidays.

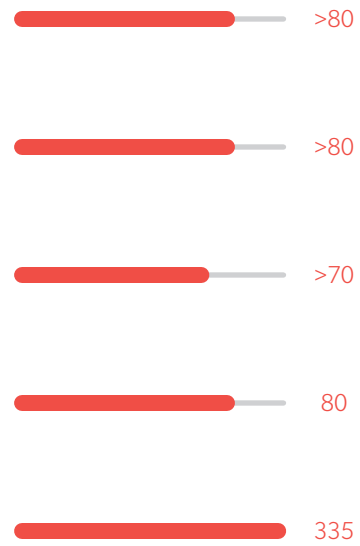
Across the supply chain, uberization promises to increase visibility and transparency for all stakeholders: which truck is nearby and has the right equipment to handle my load; which load will exactly fill out my backhaul and is along my route; what

BACKGROUND TO UBERIZATION
CONTINUED DIGITALIZATION AROUND THE WORLD

THE WORLD IN
2016



THE WORLD IN
2025



Source Oliver Wyman analysis

is the best price I can get/pay for this load that must arrive in 36 hours. By unlocking excess capacity that is now hidden due to logistics inefficiencies and origin/destination imbalances, new load-matching apps also could help offset the growing shortage of truck drivers in the US and Europe. And making load finding less frustrating could improve driver retention.

WHAT HAPPENS NEXT?

As all-in-one trucking apps evolve and become more widely adopted, they could generate disruptions that ripple outward across the supply chain. For example, consider the potential impact of smart trucking apps on private fleets. Companies with large private fleets – such as Tyson Foods or Albertsons – might be able to downsize to meet their average requirements, secure in the knowledge that smart apps used by hundreds of thousands of truckers could readily locate extra capacity when needed to meet peak demand; equally, private fleets could sell

their excess capacity into the market when their own demand is down.

Third-party logistics terminals and distribution centers also could see new and changing demands, such as increased load sharing and load exchanges, which would enable truckers to optimize their schedules and routes and expand opportunities for small motor carriers to compete against large ones.

Eventually, the many different smart trucking apps in development could narrow down to just one or a few choices – meaning marketplaces with visibility across a large share of available loads and capacity, backed by all of the tools required to make booking, transporting, tracking, and payment as painless as possible. As shippers and drivers come to expect the immediacy and ease of use that make mobile-based tools so appealing, even large contract and common freight carriers will need to modify their fleet and transportation management systems accordingly. Prior work we have done with motor carriers suggests that

technology spending is needed every year to stay current and not fall behind.

Many industries over the past couple of decades have endured the pounding of successive waves of disruptive technology – and many incumbents have foundered as a result. Right now, who reaps the value of disruption in trucking is still up for grabs. Realizing that value will require not only embracing evolving technology but also figuring out how to morph organizational and customer-facing structures in tandem (and soon). The choice is going to be as simple for trucking industry stakeholders as it has been for media, taxis, and retail shopping: Don't stand in front of a wave you can't stop.

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AVIATION GROWTH PATTERNS AROUND THE WORLD

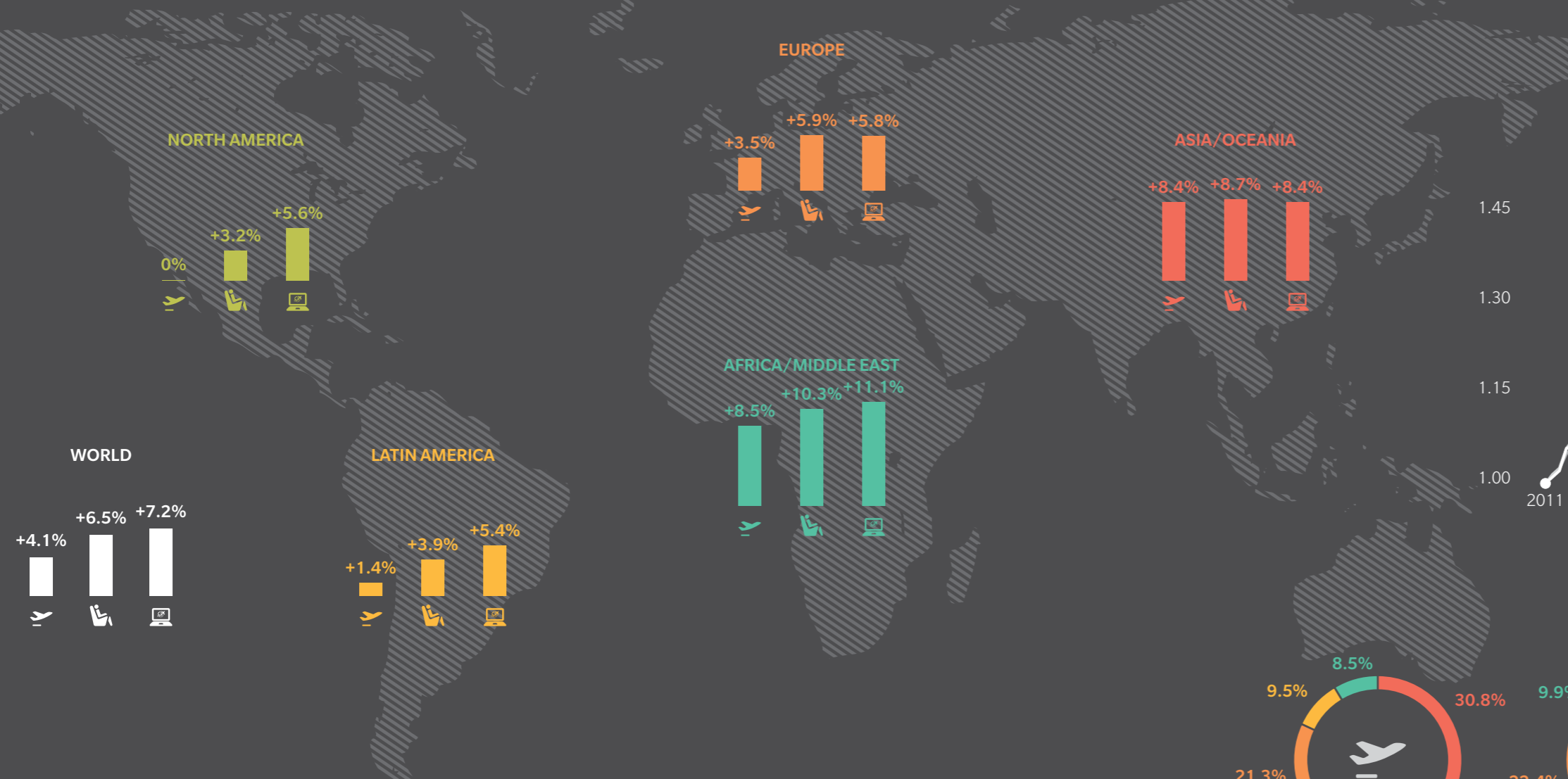
AIRLINES AROUND THE WORLD are growing, and they are doing so primarily by adding more seats and flying longer routes. Our latest research shows that year-over-year world growth in seats (6.5 percent) and available seat-miles (ASMs, 7.2 percent) is outpacing the increase in departures (4.1 percent).

Each region presents a slightly different growth picture, however. In Asia, for example, now the largest aviation market in the world, departures, seats, and ASMs are all growing by more than 8 percent year-over-year,

faster than world averages. Africa/Middle East, although a small market overall, is seeing strong growth as well – into the double-digits for seats and seat-miles.

Latin America and North America are demonstrating similar growth patterns at present: minimal to no growth in departures, a small upturn in seats, and steady growth in ASMs, which may be indicative of the impact of newer regional routes (see “Aviation’s Technology Nudge” in this issue). Europe, while a mature market, is nevertheless seeing interesting growth in capacity and miles.

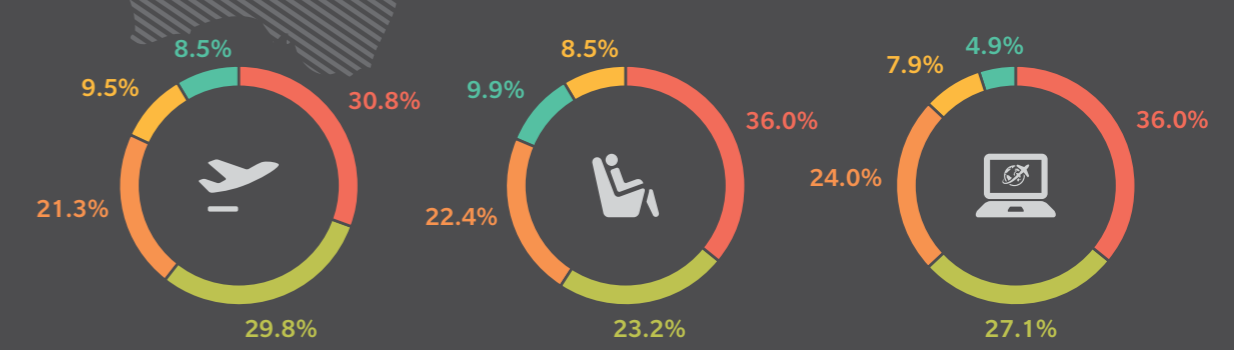
WORLD CAPACITY CHANGE
YEAR-END FEBRUARY 2015 VERSUS 2016



WORLD CAPACITY INDEX
JANUARY 2011-FEBRUARY 2016



RELATIVE AVIATION MARKET SIZE BY WORLD REGION
FEBRUARY 2016



Departures Seats Available seat-miles

Source PlaneStats.com by Oliver Wyman



A DRIVERLESS FUTURE FOR FREIGHT?

DRIVERLESS CARS ARE expected to revolutionize personal transport in the next decade, and driverless trucks and trains may not be far behind. Specialized automated trucks are already in regular use at off-road and remote locations, and over-the-road commercial trucks with partial and fully autonomous systems are being tested in the United States and Europe. On the rail side, mining giant Rio Tinto is currently phasing in the first long-distance driverless freight rail service in Western Australia. (While not freight, nearly 50 city metro rail-based systems worldwide are already automated, as are dozens of airport shuttle and people-mover systems.)

As is the case for driverless cars, the technology for autonomous freight transport is quickly becoming feasible. While plenty of obstacles remain before we see trucks and trains driving themselves, economic and competitive considerations are likely to keep the pressure on for driverless freight transport solutions. Economically, trucking is likely to benefit more than rail from going driverless, but autonomous trucks could so alter the transportation landscape that railroads might have little choice but to follow suit.

THE ECONOMICS OF AUTOMATION

Several options for driverless trucking are currently being tested. One is driverless with backup – that is, an onboard autopilot system handles a portion of the driver's duties, thereby reducing driver fatigue and stress (similar to the autopilot system in an airplane cockpit). Such a system is already legal on Nevada's roads. A second option is "platooning" – whereby a lead truck is operated or overseen by a driver, with one or more driverless trucks following behind. Fully autonomous trucking with no driver on board would be a final step, but likely require the longest timeframe to gain public acceptance.

Driverless trucking could help alleviate a growing shortage of drivers in the United States and Europe, the result of aging populations, increasing regulation, and a younger generation less willing to spend long periods away from home. According to the American Trucking Associations, the US trucking industry will be short 73,500 drivers this year – and that number could rise to 174,500 by 2024. Press reports put the current UK truck driver shortage at 50,000, while Germany could see a shortfall of some 250,000 drivers over the next decade.

Smart trucks with autopilot systems could help keep older, experienced drivers on the road, while fully driverless trucking would free up drivers for more complex local pickup and delivery operations closer to home. Another advantage of automation is that trucks would not need to sit idle during drivers' mandatory rest periods. This change alone could reduce driver costs by up to two-thirds and increase equipment

utilization by a third. Going driverless also could lead to a 70 percent drop in accident rates, meaning lower casualty claims and likely lower insurance rates. Equally, highway capacity could increase by 200 percent or more, since driverless vehicles can operate with closer spacing and at more consistent speeds.

In the case of train automation, many of the technological building blocks already exist (or are being implemented) in the US and Europe: remote control systems, onboard computers that enforce speed limits and regulate movement, and software that optimizes train operation and fuel consumption. And while railroads currently are able to fill most of their train crew jobs (pay is higher in rail than in trucking), projected retirements and the same lifestyle issues as in trucking suggest that a shortage of personnel may not be too far off. Automation would enable operating support jobs to be converted to regular shift assignments at fixed geographic locations, improving the appeal of railroading to employees who want more consistent schedules and to work near home. At the same time, railroads could reduce their labor costs and boost their network capacity. Asset utilization, service levels, and reliability could improve as well, as more frequent, shorter trains could be operated at no cost disadvantage versus current operations.

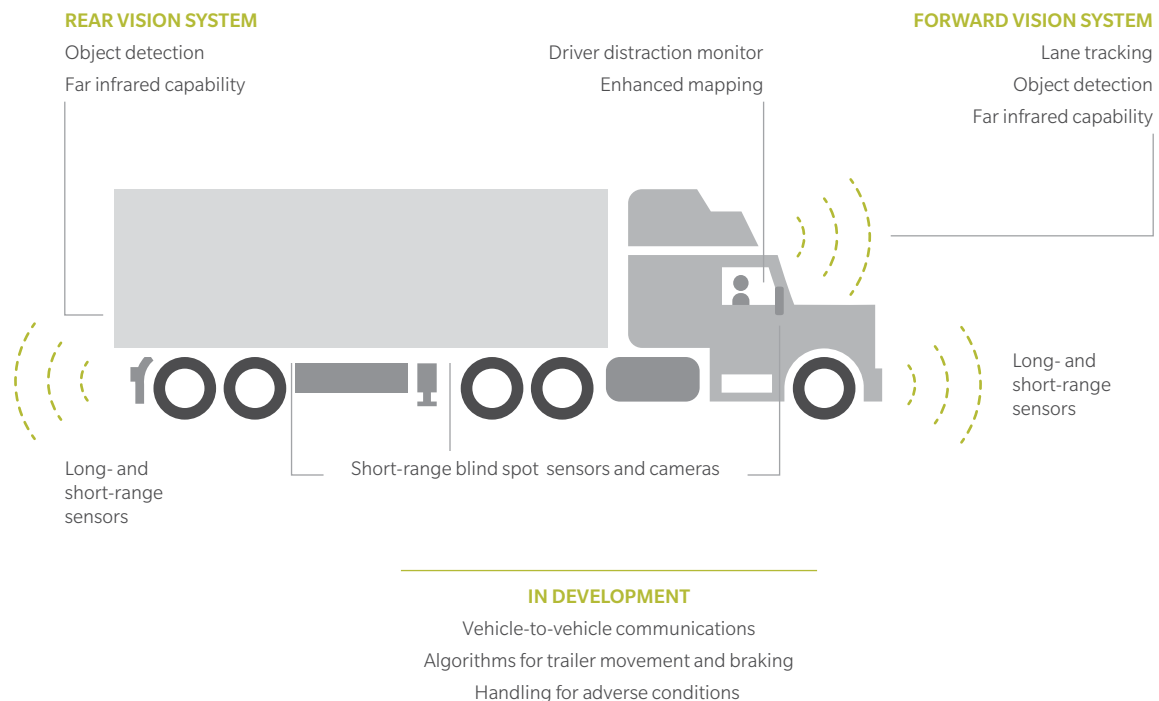
GOING DRIVERLESS: WHAT WILL IT TAKE?

For freight railroads, the critical barrier at present is that trains cannot detect and avoid obstacles in their paths. Several different strategies in tandem will likely be needed to overcome this problem, such as real-time monitoring systems for grade crossings and navigation app-based alerts for car drivers when they are approaching crossings. As real-time train tracking becomes more common as well, it's not hard to envision a future of mobile devices warning drivers and pedestrians of an oncoming train in their vicinity.

Of course, no rail corridor can be completely sealed off, which means trains will need obstacle detection and avoidance systems. Autonomous cars, for example, use light detection and remote sensing technology, linked to the braking and steering systems, to avoid obstacles. The challenge for a train will be determining what an obstacle is and whether to brake for it, since sudden deceleration creates a risk of derailment. Is it a car that can't get out of the way – or a deer that can?

For autonomous trucks, the challenge is somewhat different, and likely greater, given that trucks operate on open roads with full public access. A phased approach may make the most sense: Autopilot systems, once they demonstrate their safety and reliability in testing, could

TECHNOLOGY BUILDING BLOCKS FOR AUTONOMOUS TRUCKS



be an entry point for licensing. These systems could then be gradually expanded over time to take on a larger share of tasks or to control trucks as part of a platoon.

Safety concerns might lead to public demand that fully driverless trucks initially operate on dedicated and segregated highway lanes. But while converting some lanes to autonomous-only vehicles would likely add highway capacity (and thus cut congestion), this approach could be a political non-starter unless there are sufficient lanes in each direction to serve conventional drivers as well.

AUTONOMY: THE NEXT COMPETITIVE EDGE

The technology for driverless trucks and trains will largely be in place within the next few years, and the economic imperative will only escalate. Driverless trucking faces more hurdles but has more to gain

in terms of solving long-term industry structural problems. Railroads could face regulatory and labor union issues, but automation would be easier to implement from a technology standpoint.

Most critically, automation could reduce motor carrier costs enough to make them competitive with rail over longer distances. If this happens, failure by the railroads to move quickly enough in response could lead to a loss of market share that would be difficult to make up.

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Operations



FORESTALLING THE FUTURE WITH PREDICTIVE MAINTENANCE

PREDICTIVE MAINTENANCE IS one area in transportation that is innovating on two fronts – drawing from both big data and the Internet of Things. And it is growing: A recent survey by Oliver Wyman in the aviation maintenance, repair, and operations (MRO) space found that more than half of the companies surveyed are planning more investment in predictive maintenance over the next five years. That's because a holistic program of predictive maintenance can increase asset reliability and availability, as well as generate savings in areas such as labor and material costs.

The implementation of such programs, however, is anything but simple. To fully capture the benefits of predictive maintenance modeling and analytics can require a level of transformation that companies often initially underestimate and fail to engage around. Predictive maintenance is more than just a technical shop project – it requires comprehensive

support – spanning from procurement and operations planning to top management.

THE BENEFITS OF PLANNING AHEAD

As its name implies, predictive maintenance uses techniques to determine when in-service equipment is most likely to need maintenance. Timing maintenance procedures to match maintenance needs is improving rapidly, thanks to big data analytics, while smarter equipment is able to provide operators with real-time condition information.

By reducing time-consuming routine maintenance, for example, experts estimate that Airbus's and Boeing's predictive maintenance systems in the aviation space could increase fleet availability by up to 35 percent. Similarly, asset monitoring means that parts are replaced or repaired only when needed, rather than using traditional time- or distance-based

intervals. Train manufacturers estimate that use of asset monitoring tools can reduce material-related costs by up to 15 percent.

By triggering specific maintenance operations only when they are actually needed, predictive maintenance helps optimize maintenance planning and allocation of capacity (such as teams and workshops), which in the airline industry alone could reduce maintenance labor costs by 5-10 percent. Finally, customers benefit too when equipment breaks down less: In Singapore, the introduction of predictive maintenance reduced the number of train breakdowns from 3.3 to 1.3 per 100,000 train-km between 2012 and 2014.

DEPLOYMENT CHALLENGES

Deploying predictive maintenance is a three-step process, and each step comes with its own trials:

Collection of relevant real-time data: Key onboard metrics must be defined

and data collected from a broad and growing range of sensors that enable increasingly accurate assessment of asset condition. Predictive maintenance algorithms also require collecting relevant data from external sources, such as prior maintenance done on the asset and baseline information from original equipment manufacturers (OEMs).

Data processing and analysis: Analyses must be geared toward determining estimated remaining useful life of components and spotting irregularities in asset functionality that might signal a need for maintenance intervention. Typical challenges include developing algorithms that translate data into usable results, scarcity of talent (such as data scientists), and gaining access to data that might be limited by OEMs' proprietary protocols.

Forecasting and acting: Defined actions should be triggered based on rules integrated into the predictive model. Finding the right threshold to trigger an action is critical, especially to avoid over-maintenance. Information technology interfaces may require upgrading to ensure actions are triggered across all relevant systems, such as maintenance planning and procurement.

SOLVING THE PUZZLE

Successfully introducing predictive maintenance requires finding innovative solutions to these challenges, which in turn may necessitate some level of transformation across the company. There are five areas that may require extra attention to make predictive maintenance happen:

Talent: According to the *Harvard Business Review*, two-thirds of Fortune

500 companies believe that they have a talent gap when it comes to big data analytics – a critical capability needed to make predictive maintenance work. One way to address this problem can be through cooperation with advanced big data firms. For example, to develop the concept of Digital Twin (a data model of a specific physical asset), GE Aviation collaborated with its sister company, GE Digital, to consolidate the digital capabilities of the industrial group.

IT infrastructure: Requirements for predictive maintenance IT usually differ significantly from other systems, as these systems need to be real-time, highly interfaced, and extremely secure. Implementation of predictive maintenance may thus require major modernization of IT systems. The airline industry is dealing with this problem now, for example, as three-quarters of its IT systems were installed prior to 2002.

Data management: Data acquisition raises many issues, including quality and usability of data collected and data ownership. One solution widely adopted by leading companies is to set up a dedicated structure, such as a data lab, with responsibility for managing the predictive maintenance system and data flows across the company.

Functional coordination: Maintenance planning and parts procurement must be done in real time to make predictive maintenance work, which often exposes a lack of coordination among maintenance, operations, and supply chain teams. In the UK, operator Virgin Rail and manufacturer Alstom Transport developed a tool called HealthHub to align their roles. The tool calculates the remaining useful life of components and automatically triggers

actions across the value chain, such as maintenance activities planning and spares ordering.

Supplier relationships and contracts: Predictive maintenance can support stronger operator-supplier relationships and more innovative contract models. By jointly analyzing performance data, for example, operators can negotiate with manufacturers for targeted levels of performance or equipment availability, while manufacturers can secure more lucrative contracts if they can supply spares and repair services in response to real-time equipment needs.

Of course, to make these changes work at a transformative level also requires strong top-down engagement, on-boarding and buy-in across functions, a sound business case, and rigorous program management. Regardless, no crystal ball is needed to understand that predictive maintenance must be part of the future for transportation companies looking to ensure long lives and top-notch performance from their assets.

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A NEW GENERATION OF MEDIUM-SIZED, long-range, and fuel-efficient aircraft has opened up non-stop routes that not long ago would have seemed incredible: London, UK to Austin, Texas; Birmingham, UK to New Delhi, India; Stockholm, Sweden to Oakland, California; and San Francisco, California to Chengdu, China, to name just a few.

This technology is connecting mid-sized secondary and small regional markets that previously would have required a stop somewhere along the way to serve long-haul destinations. It's an evolution of technology, rather than a revolution: These new aircraft aren't turning unprofitable airlines profitable, changing travel habits,

or killing off airports. Airlines and airports remain locked in competitive dynamics and still must find innovative ways to draw in passengers and remain relevant. But the new aircraft, if used intelligently, could provide a welcome competitive tool for airlines. At the same time, major hub airports will need to work harder to keep up as the technology boosts traffic and service levels at secondary and regional airports.

NEW PLANES, NEW MARKETS

New aircraft like the Boeing 787 and the Airbus A350 seat fewer passengers than

their long-range counterparts (such as the Boeing 777 and Airbus A380), making it possible for airlines to serve medium- and long-haul markets worldwide that otherwise would not have enough demand to support large aircraft. Airlines can use the planes to schedule more non-stop services, thereby increasing travel time flexibility for business travelers, while higher service levels can be offered at an attractive cost per seat, appealing to business and leisure travelers alike.

Airlines are using the technology to explore some interesting new business models, such as low-cost service for longer flights or to feed network carriers'

hubs. For example, British Airways has launched a London-to-Austin route that uses a 787 with just 214 seats – a roomy, passenger-friendly seating arrangement compared to most transatlantic flights. At the other end of the density spectrum, Norwegian Air Shuttle is now operating low-cost flights from Scandinavia and London to North America, using Boeing 787s configured to hold 291 passengers.

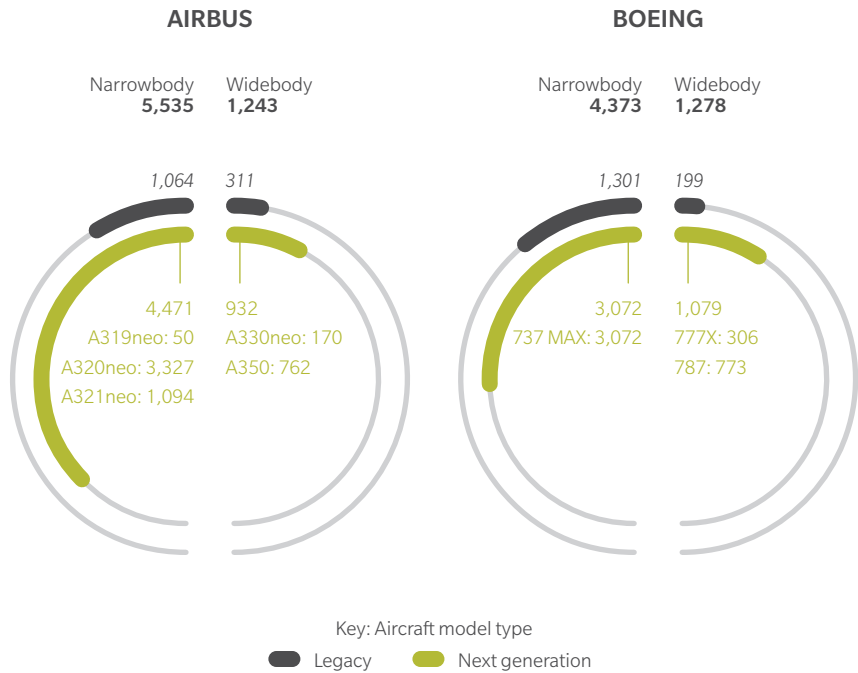
The next generation of smaller, single-aisle aircraft now being built, with around 180 seats (the Airbus A320neo and the Boeing 737 MAX), will add around 500 miles of range over existing models. This will make possible another wave of potential regional routes between the East Coast of North America and Western Europe. WestJet is already testing the potential for such services on Dublin, Ireland-St. John’s, Newfoundland and Halifax, Nova Scotia-Glasgow, Scotland routes, using its existing 737s.

Still, these examples don’t indicate fundamental change to the industry. Rather, they show that airlines are experimenting with how the new technology can be used to increase their competitiveness and open up new markets, while maintaining their traditional hub-and-spoke networks. As a result, many airlines also are using the new planes in traditional ways. For example, British Airways has put 787s on its London Heathrow-Toronto, Canada route to replace larger 777s and aging 767s.

THE STICKINESS PROBLEM

Long-haul point-to-point services will increase passenger traffic through some secondary and regional airports, which could reduce the dominance of some hub airports. They are unlikely to be more than a blip on the radar, however, for the largest hub airports and the tens of millions of passengers they carry each year. Hubs that do find themselves under pressure will need to work on making themselves as “sticky” as possible for customers. This will require putting the customer at the center of all activities and delivering a client experience that is a true differentiator – one not easily matched by competitors. This might include state-of-the-art services and operations, such as the fastest and most

LEGACY VERSUS NEXT-GENERATION PASSENGER AIRCRAFT ORDERS



Note As of December 2015. Excludes aircraft models for freight or military use; Airbus (A330-200F) and Boeing (737-800A, 767-300F and 777F)
Source Airbus, Boeing, Oliver Wyman analysis

convenient connection services, or top-of-the-line entertainment and shopping. Another option could be innovative collaboration with other stakeholders in the travel value chain, such as joint marketing campaigns with local city, tourism, and hotel organizations to drive incremental demand.

And then there are the innovations to be had from “going digital.” For example, when travelers face a choice over which airports to use, digital innovations such as wayfinding apps or automated parking/transit systems could tip the balance for some customers. At the same time, a “digital inside” focus would seek to maximize data automation and digitalize processes that connect the airport to airlines, ground handlers, and other air service providers.

LOOK BOTH WAYS NOW

The most important lesson of the new aircraft technology now in use and coming online over the next few years

is to remind airlines and airports that the choices available to customers are greater now than ever before – and these choices will only multiply. Generating future value will require looking to both the past and the future: embracing innovations such as digitalization, while working harder to achieve traditional strategies such as customer service and operational excellence.

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NORTH AMERICAN FREIGHT RAIL: EVOLUTION REQUIRED

NORTH AMERICAN FREIGHT RAILROADS are currently caught up in an unstable environment that is shifting on many different fronts. Their baseline energy traffic is eroding – some of it for good. They face structural industry changes that will impact their businesses for the foreseeable future. And innovations in the trucking industry may challenge the railroads in new ways. What will it take for the railroads to acclimate and prosper?

THE DROP-OFF IN COAL AND OIL

One of the biggest issues for North American freight railroads is the rapid decline in coal traffic, which accounts for a third of rail tonnage, and which fell by 12 percent from 2014 to 2015 alone. Coal is being replaced by cheap and abundant natural gas as well as renewable energy for electricity generation. In 2015, natural gas surpassed coal as the top fuel source for electricity, while renewables accounted for 68 percent of new US electric generation capacity installed.

Crude oil poses similar concerns. A boom in domestic production over the past ten years added many thousands of rail carloads, as North American pipelines were unable to keep up with the rapid increase in this trade. But crude now looks unlikely to grow beyond its current 3 percent of rail tonnage. Pipeline infrastructure is being added and low oil prices have led to a drop in drilling. Pipeline was already half to one-third cheaper than rail for crude oil movements;

in the future, it will likely be an even better value as crude-by-rail costs increase due to new regulations.

MEXICO AND E-COMMERCE MOVES

The automotive industry is picking up its tools and moving large portions of production to Mexico, which bodes well for US-Mexico cross-border rail, but is reducing US-Canada cross-border and US domestic rail movements. A number of other manufacturing industries also are increasingly near-shoring in Mexico, thanks to its more than 40 free-trade agreements.

Another large slice of the rail business, intermodal traffic (containerized freight) is being impacted not only by increased Mexican manufacturing but also by the continued movement of both wholesale and retail buyers from brick-and-mortar stores to the Internet. These customers will increasingly expect same-day or even two-hour delivery windows. In response, e-commerce giants are developing larger, faster networks that can support shorter hauls between ports/warehouses and distribution/fulfillment centers.

CONTINUING COMPETITIVE PRESSURES

Existing and potential developments in trucking are adding to railroads' competitive challenges. Right now, low fuel prices are proving to be a great boon for trucking, which is less fuel efficient than rail. Trucking companies have been able to raise driver wages without increasing



rates, thereby reducing turnover and slowing the pace of what is expected to be a long-term driver shortage.

In the medium term, there's the threat that size and weight limits could change, meaning that trucks could get longer and heavier. Those in favor cite economic and environmental benefits from loading more freight on each truck; those against are concerned about safety and yet more damage to tired infrastructure. Congress is currently studying the issue, but we expect that larger trucks are indeed on the horizon.

BECOMING THE BEST OF BREED

For the North American freight railroads, ensuring their survival under the weight of these changes will mean evolving to offer greater speed and flexibility, so as to better serve just-in-time manufacturing and exports, as well as e-commerce driven containerized goods. The result is that North American freight rail may need to become a bit more like European freight rail, in the sense of running higher-frequency trains.

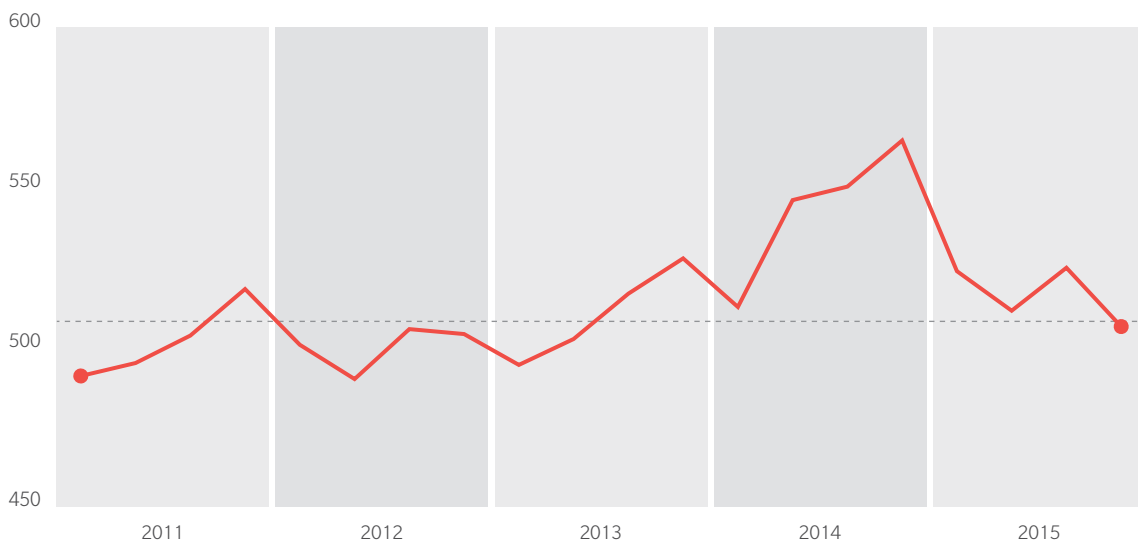
Running more frequent trains can serve two goals: improving shipping reliability and improving asset cycle times and overall costs, by reducing the time trains sit idle between departures (dwell time). Generally, running more frequent trains requires breaking up traditional

single-commodity trains, such as those that carry intermodal, coal, or grain, and mixing traffic on trains instead (as smaller "blocks" of railcars). As one railroad in North America is already doing, mixing blocks of different commodities keeps train sizes stable, but enables more frequent departures, as the cars do not sit waiting until there are enough of one type to make up a train.

This approach is going to be increasingly desirable, as it caters to a consumer-based economy that requires smaller, more frequent, and highly reliable shipments to meet the needs of fast-turn supply chains (e.g., retail stores, Amazon fulfillment centers). Large volume, 100-plus car shipments, on the other hand, are a declining share of the railroad business. In 2015, average train speeds increased by more than 10 percent, but average dwell time and railcars on-line remained high, suggesting no change or even longer wait times for train departures – this is a situation that will have to change if railroads are to correct their current slowing growth trajectory.

We also may be seeing the beginnings of a more regionalized North American economy, with origins being clustered closer to destinations. As an example, auto parts plants are being built close to car assembly plants, creating a cheaper, faster, and more dependable supply chain. Another example is container board

CLASS I NORTH AMERICAN RAILROAD TON-MILES
2011-2015 (QUARTERLY DATA)



Note Includes BNSF, CN, CP, CSX, FXE, KCS, NS, and UP
Source Oliver Wyman analysis

production: Historically, producers sent products out to customers across the country from a single plant. Now, large producers maintain a plant in each major production area, so that they can deliver product from the plant closest to each customer.

Logistics terminals that facilitate the transfer of goods between modes (such as rail-truck) also are now being increasingly co-located in high-density business districts with facilities that can process a range of commodities (plastics, lumber, steel, building materials) and distribution centers for finished, containerized goods. Compressing distances in these ways could drive the development of new regional services, including blended trains (with a mix of bulk commodity, automotive, and containerized traffic) and more direct point-to-point services.

This is not the first time the North American rail industry has been forced to adapt. Thirty years ago, new emissions regulations led to long trains moving low-sulfur coal, rescuing an industry in the throes of bankruptcy. Now another energy revolution, coupled with logistics innovations, will likely require the industry to make another breakthrough transformation, adapting to shorter distances and smaller shipment sizes, while delivering the speed and reliability that are the hallmarks of a precision supply chain.

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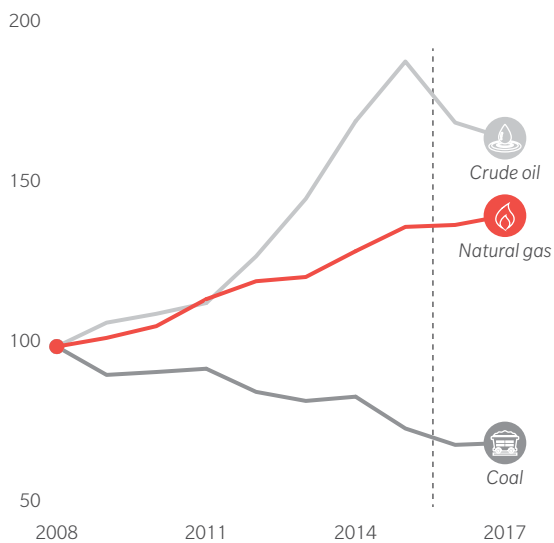
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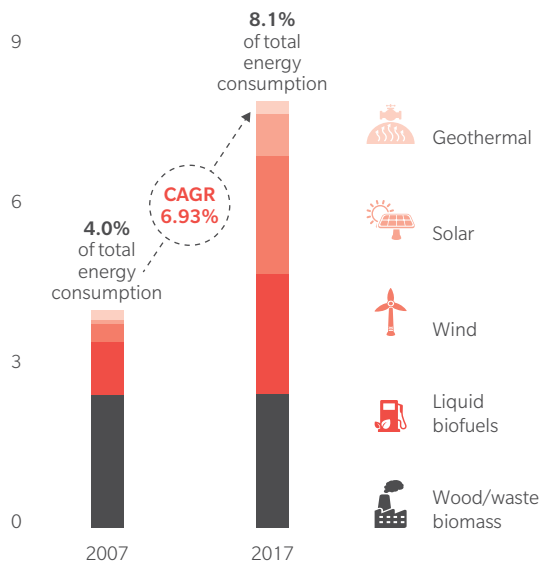
David Hunt, an Engagement Manager in the Transportation Practice, also contributed to this article.

INDEXED US ENERGY PRODUCTION 2008-2017



Note Index basis: coal production: millions of short tons; crude oil: million barrels per day; dry natural gas: billion cubic feet per day
Source US Energy Information Administration

US RENEWABLES (NON-HYDRO) ENERGY CONSUMPTION QUADRILLION BTUS



Note Does not include hydroelectricity. Wood biomass is wood and wood-derived fuels. Waste biomass is municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural byproducts, and other biomass. Liquid biofuels are ethanol, biomass-based diesel, and co-products
Source US Energy Information Administration

OPTIMIZING END-OF-LIFE FOR BIG ASSETS

WITH MORE HIGH-TECH COMPONENTS and ever more stringent regulations to meet, the costs to own, lease, and maintain transportation assets keep going up. On top of this, the expense of maintaining a plane, ship, or piece of rolling stock in top shape generally increases as an asset ages. End-of-life or end-of-lease can be a particularly fraught time for decision making about when and whether to undertake repairs and overhauls.

Too often, the approach to keeping costs from spiraling as an asset's expiration date nears is a throwback to another

time: manually developing an end-of-life maintenance plan for the final 6-12 months of use. This approach narrows down the options available to optimize use versus costs, however, and so can be a recipe for wasting millions of dollars in unused asset uptime, unexpected maintenance, or lease return penalties.

Our research has shown that asset end-of-life planning needs to start much earlier: three to five years in advance of retirement or lease return, to provide maximum flexibility. This planning also must move into the information age – utilizing

an integrated, holistic modeling approach and big data tools and techniques to fully account for the complexity of multiple assets with different return or retirement requirements. As an example, an airline might have 200 to 300 aircraft with widely varying lease return dates and terms.

BALANCING COSTS AND USAGE

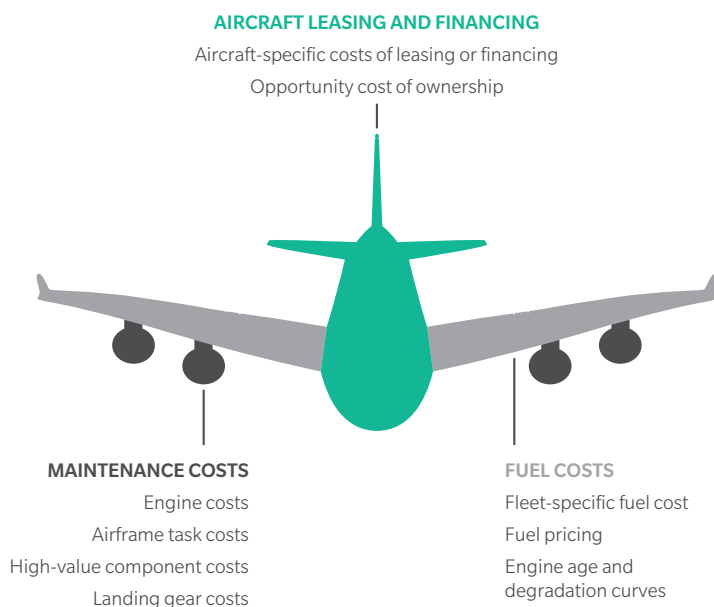
It's odd that companies which employ some of the most advanced operational research tools in the world often don't apply similar analytical might to their fleets. Yet today's optimization modeling tools and techniques can bring together many variables – such as utilization, asset maintenance history, lease return conditions, and projected used asset availability and market pricing – to extract the most value from each and every asset.

End-of-life optimization works to increase asset availability and minimize costs by considering the most intelligent use of assets across a fleet and how assets should be sequenced: In the case of an aircraft engine, for example, when should the engine go on a wing, when should it move to a lower-mileage service, and when should it become a spare to ensure that it is returned with exactly the amount of lifespan required by the lessor? Ultimately, optimization modeling allows remaining asset uptime to be balanced against the residual value of the asset.

SIMPLIFYING LEASE VERSUS BUY

It is also useful for making "lease versus buy" decisions and contract-length

COMPONENTS OF TOTAL FLEET COST AVIATION EXAMPLE



decisions for leased assets, as modeling can factor in the supply and pricing dynamics of the used asset market, the impact of remaining uptime at retirement on value, or provide ideas for better alignment to lessor-stipulated return requirements.

As an example, a delivery surge in the early 1990s means that airlines will likely retire more than 11,200 aircraft over the next decade, nearly twice the number retired over the past ten years. Many of these aircraft are leased, and preparing an aircraft for redelivery to a lessor can be a costly process if not planned properly. Some airlines will face tens of millions of dollars in last-minute maintenance costs, late redelivery penalties, and out-of-service downtime.

By thinking about lease return optimization more holistically over a longer time period, however, an airline has more options. These include more efficient engine swapping, life limited part (LLP) programs that match parts to the remaining life of the leased assets, and more proactive and predictable surplus parts management. In our experience, such planning can help an airline save an average of \$2 million

per redelivered aircraft in maintenance costs alone.

Similarly, asset maintenance in the rail and maritime industries represent large and complex cost buckets. "Own versus lease" is a common dilemma and asset lifespans are both long and somewhat flexible: Older rolling stock and ships can be cascaded down into secondary services or even rebuilt. These industries also face volatile markets that make sophisticated modeling and scenario evaluation even more necessary, as multiple "what if" choices can be explored to optimize the tradeoff between maintenance/overhaul costs and the likelihood of generating future revenues.

EMBRACING A DATA-DRIVEN FUTURE

We expect that end-of-life optimization modeling will eventually become the norm for transportation industries with life-limited assets that require complex maintenance and operate in highly regulated environments. Evolving such an approach sooner rather than later, however, will make it easier to incorporate anticipated "digital industry"

developments, such as an expanding flow of real-time information from smart assets (for example, streaming health monitoring) and more coordinated information sharing between operators and manufacturers. These upgrades will provide even more opportunities to plan ahead, making end-of-life decisions more a matter of choice than chance.

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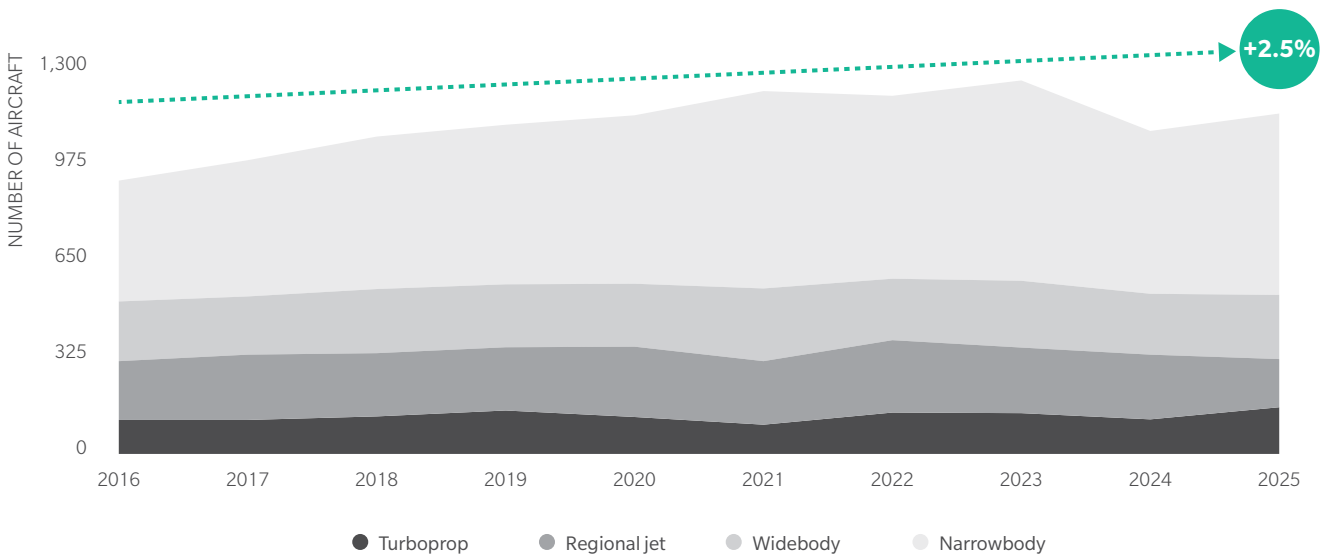
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GLOBAL AIRCRAFT RETIREMENT FORECAST
2016-2025



Note Excludes government and military
Source betterinsight™ by Oliver Wyman

SPEEDING UP AEROSPACE INNOVATION



THE AEROSPACE INDUSTRY is moving from a ten-year development cycle to a need for immediate, on-demand services. This means that as original equipment manufacturers (OEMs) move into the testing and delivery phases for a new round of aircraft models, their attention will need to turn from long-term projects to a range of short-term issues associated with launch, support, life extension, and operational flexibility. These issues are not new, but a record volume of deliveries and the emergence of new customers will make quick resolution of any challenges paramount.

At the same time, OEMs must determine how they will facilitate and accelerate longer term growth, particularly in the aftermarket. Crucially, OEMs find themselves facing off against aftermarket maintenance, repair, and operations companies (MROs) to serve emerging markets and clients.

GOING BEYOND THE BACKLOG

Major OEMs currently have up to ten years of production in backlog, and the required delivery rate for new products keeps on accelerating. Most critically, as aircraft and engine orders are delivered, they will not be replenished at the same speed. Manufacturers therefore will need to complement their revenue and earnings with aftermarket growth. Integrated and differentiated services that reduce downtime while improving the performance of the existing fleet will be particularly vital. We see two opportunities here for OEMs to set themselves apart: product strategy and delivery.

In terms of product strategy, OEMs will need to propose products and services that differentiate them from competitors and leverage their design-related

intellectual property. Without any new, large programs, that means quickly developing incremental innovations. Rather than making one big bet on a new aircraft model or engine, companies will need to make thousands of small, quick-turnaround bets on new ideas and technology. Additive manufacturing (3D printing) and predictive maintenance are examples in the aftermarket.

On the delivery side, OEMs will have to reduce lead times both on the factory floor and across the aftermarket while lowering the risks associated with upstream materials and suppliers. Similarly, manufacturers will need to improve shop-floor work instructions while rapidly integrating systems for final assembly. Under pressure from the changes coming about due to the development of “digital industry,” engineers will need to shift from managing multiple development cycles over long periods of time to solving problems in real time.

It’s important as well that OEMs empower local leaders to make the split-second decisions that are required to maintain efficient operations. Typically, a shop manager within a factory may oversee several hundred workers and is responsible for the end-to-end performance of what boils down to a profit unit. The shop manager thus needs the skills and decision-making power to collaborate seamlessly with all relevant functions (supply chain, quality control, technical, work preparation, etc.). The same pattern should be followed for local management in engineering, procurement, and sales, such that cascading empowerment permanently boosts performance.

THE AFTERMARKET RACE

As their backlogs wane, manufacturers will need to grow after-sales margins in the face of fierce competition from

MROs, which are innovating at a rapid pace. MROs are moving to adopt new technologies and solutions such as big data analytics, aircraft health monitoring systems, predictive maintenance, new repair technologies, and additive manufacturing. At the same time, large MROs keep on expanding the range of services they offer to operators and lessors, thereby reducing the need for operators to maintain high parts inventories and helping them avoid long grounding periods for aircraft. The MRO market is expected to grow from \$67 billion last year to \$100 billion in 2025, and at least 10 percent of this value is projected to be in the area of completely new services.

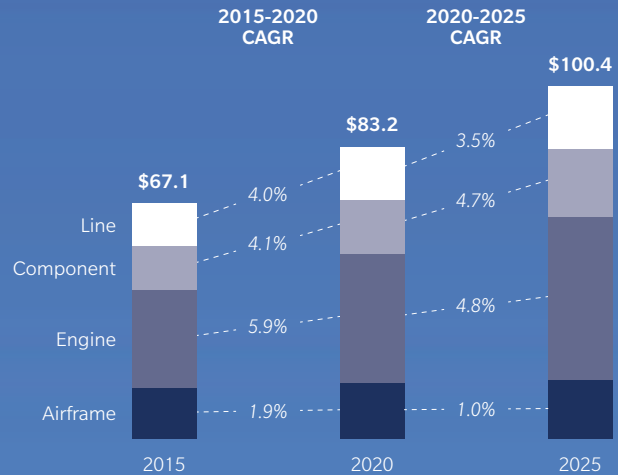
In addition, the focus of competition between OEMs and MROs is likely to shift increasingly to emerging markets that are seeing high levels of fleet growth, such as Asia. In these newer markets, after-sales services are as yet fragmented and uncoordinated, with low levels of workforce and logistics maturity. In these cases, OEMs looking to capture a larger share of the aftermarket from MROs could leverage their strong supplier relationships and sophisticated supply chain networks to offer new integrated service bundles, parts management, and logistics solutions.

The engine for new growth in the aerospace industry will be faster definition and roll out of strategies to accelerate production and meet the demands of a growing aftermarket. OEMs will need to continuously innovate to counter their competition and take advantage of the large opportunities that will be offered by the aftermarket over the next decade.

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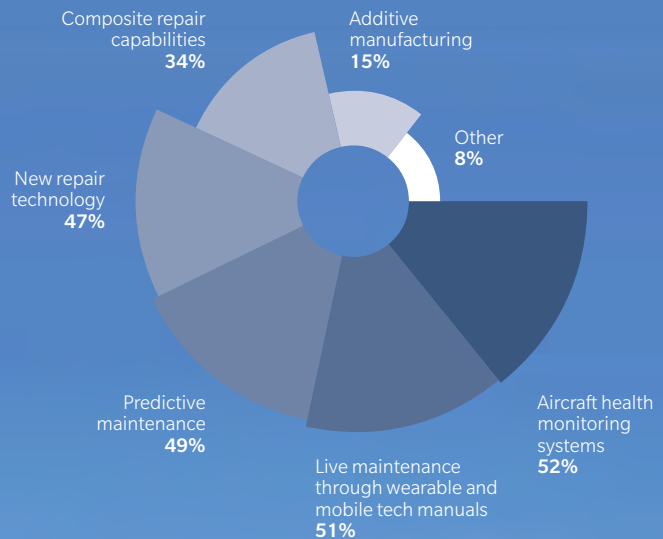
GLOBAL MAINTENANCE, REPAIR, AND OVERHAUL MARKET FORECAST BY SEGMENT (\$ BILLIONS)



Source CAVOK Global Fleet and MRO Market Forecast

AEROSPACE COMPANY SURVEY

HAS YOUR ORGANIZATION APPROVED INVESTMENT FOR DEVELOPING ANY OF THESE TECHNOLOGIES NOW OR IN THE NEXT FIVE YEARS?
Percent of survey responses (multiple selections possible per category)



Source Oliver Wyman 2015 MRO Survey



ARE COBRANDED TRAVEL CARDS REWARDING ENOUGH?



THE CREDIT CARD MARKET is intensely competitive. In the United States alone, the ten largest issuers offer some 140 cobranded travel rewards credit cards. Cobranded travel cards are popular with consumers, who receive points that they can use for free flights and hotel stays; and with travel suppliers, as a means to grow their share of a travel market that totals \$1 trillion annually in the US, according to the US Travel Association. But their popularity may be in danger, as bank-issued rewards cards offer incentives that may have more appeal than current cobranded travel card offers.

Most airlines and hotel chains offer a cobranded card. It's no surprise that they do, as cobranded travel cards have been shown to solidify brand loyalty and increase consumer share of wallet – by two or three times as much for airlines and up to seven times as much for hotels, compared to what the average travel consumer spends with an airline or hotel chain. But the sheer number of rewards-based cards makes it a struggle to stay ahead of the pack. Furthermore, generational and technology changes are emerging that will require travel suppliers to innovate as never before if they want to keep their cards in travelers' pockets.

RAMPING UP REWARDS

Credit card holders do value cobranded travel cards, according to an extensive survey we recently conducted of the US cobranded card market: 80 percent of card holders believe that they offer as much or more value than bank-issued rewards cards. But consumers also are willing to switch when the grass appears greener: 40 percent change their primary credit card at least every two years.

This leads to a critical question for airlines and hotels – how do they persuade consumers to acquire their specific cobranded card, spend with it, and not switch to the next card that comes along? The data tells us that better rewards are the reason for half of primary credit card switches. Even customers who carry a balance month-to-month are more likely to switch because of rewards than due to a lower interest rate. Not that interest rates don't matter – cobranded travel card holders are twice as sensitive to higher interest rates than those who

hold bank credit cards, and high-frequency travelers are four times as sensitive as low-frequency travelers.

So the answer to the question above appears to be better and differentiated rewards and benefits, as these exert the greatest influence by far on a consumer's decision to acquire a cobranded travel card, together with moderate interest rates. Card attributes such as issuer, network, and sign-up bonus are taken into consideration as well by consumers, but count considerably less in decision making.

To create offers that "stick" with consumers, travel suppliers will need to carefully consider the needs, preferences, and travel and purchasing behaviors of their target customers, and use these inputs to develop differentiated and innovative rewards packages. Benefits like discounts on in-flight meals and room service or elite-level qualifying points for purchases are popular among travelers. But they are becoming increasingly common as well.

Our research suggests companies need to take a harder look at rewards that are highly personalized, experience-based, offer more choices, or that are perceived as exclusive, particularly for higher-spend card users. Such rewards might include flight simulator tours, suite upgrades at prized properties, or private dinners with renowned chefs. Creating products that combine both better rewards and interest rates is another route to consider, as these would appeal to customers who carry a balance. The effort would be worth it: Such customers account for more than 80 percent of credit card profits for partner banks; these in turn underwrite travel suppliers' rewards programs.

At the same time, airlines and hotel companies must continue to maintain strong travel rewards redemption programs, as over half of cobranded travel card holders are infrequent travelers and primarily want to earn and redeem reward points for flights and rooms.

NEXT-GENERATION CONSIDERATIONS

In addition to increasing the appeal of their cobranded travel cards for current travelers, travel suppliers need

to think seriously about the future. In particular, how will they deal with generational shifts in consumer preferences and payment behavior?

Today, only a third of credit card-carrying Millennials (the generation aged roughly 18-34) hold a cobranded travel card, compared to half of credit card users who are their parents' age. These tech-savvy consumers value different features and use credit cards in a different way than older generations. For example, Millennials like being able to customize physical card designs. They also expect credit card payment capabilities and other features to be wholly integrated with their digital lives.

Millennials are two and a half times more likely than the overall market to use mobile wallets as their primary spending method. Features like keyless check-in and an invisible payment experience within the travel supplier's mobile application are the starting line for this segment. Winning the wallets of this generation as they age will require figuring out what rewards and experiences they most value. The good news for travel companies is that Millennials exhibit a passion for travel, spending a greater share of their income on flights and hotels than any other age segment.

In summary, cobranded travel rewards credit cards are an incredibly powerful financial- and brand-boosting tool for travel suppliers. To counter

growing competition and ensure that their cards continue to be relevant, airlines and hotels will need to design rewards programs that balance strong travel points redemption options, differentiated and novel benefits, and interest rates. And they must start crafting strategies now to deliver next-generation cobranded travel card programs that can encompass evolving technology and changing consumer lifestyles.

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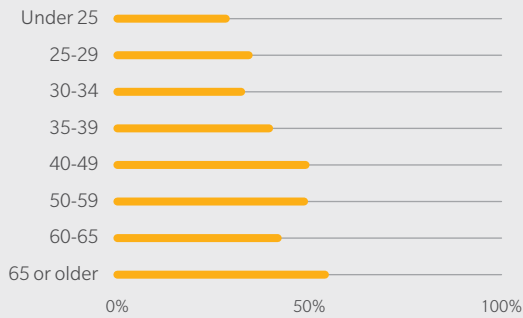
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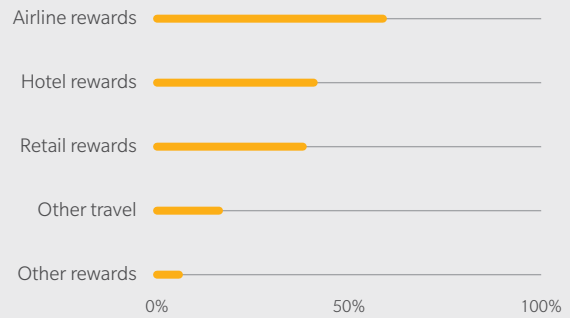


COBRANDED CARDS: SURVEY HIGHLIGHTS

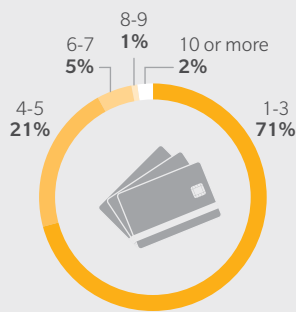
DO YOU HAVE A COBRANDED CARD?



WHAT TYPE OF COBRANDED REWARD CARD WOULD YOU CONSIDER APPLYING FOR?



WHAT IS THE MAXIMUM NUMBER OF CREDIT OR CHARGE CARDS YOU WOULD BE COMFORTABLE CARRYING?



IN THE FUTURE, WOULD YOU CONSIDER APPLYING FOR A COBRANDED CARD?

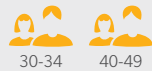
77%
of people answered yes

WHAT NEW FEATURES WOULD YOU BE MOST INTERESTED IN SEEING IN A NEW COBRANDED REWARDS CARD?
Preferences by age group

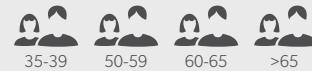
#1 preference



#2 preference



Discounts on reservations with the cobranded merchant (e.g., discounted tickets, room rates)



Elite-level qualifying miles or points



Upgrades to existing reservations



Accrual benefits from other card issuer products (e.g., checking account, mortgage)



TRENDING:

RANKED MORE STRONGLY BY <35 AGE GROUPS

- Increased options for card designs
- Merged mobile app for issuer and cobranded merchant
- Mobile/innovative payment capabilities

Source Oliver Wyman 2016 Cobranded Travel Rewards Credit Cards Study

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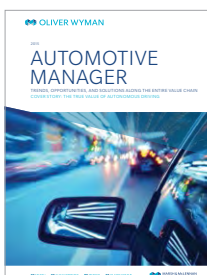
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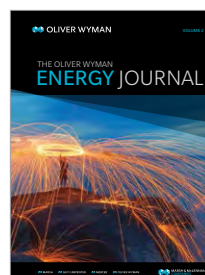
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