



VELOCITY

The Journal of Travel, Transport & Logistics 2018

TO OUR READERS

To paraphrase Bette Davis in “All About Eve,” *fasten your seatbelts. It’s going to be a bumpy decade* – but an exciting one.

The theme of **VELOCITY** this year is disruption and how to capitalize on it. As far as the eye can see, transportation and related industries like hospitality and logistics are headed for change – not incremental alterations to which businesses can easily adapt, but rather fundamental, potentially destabilizing transitions that will require substantial investment, agility, and new strategic thinking.

The main perpetrator, as it has been since the advent of the internet, is technology. But where it once took a decade to unhinge an industry, new technologies a few years old now have the potential to redefine the rules. Take, for instance, smart speakers which only made their debut in 2015; by the end of 2017, more than 43 million Americans and 100 million people worldwide owned one, with projections those numbers would more than double by 2020.

Today, smart speakers are on the cusp of reshaping the travel industry, as we discuss in the issue of **VELOCITY**, but the artificial intelligence that makes them possible is restructuring almost every aspect of transportation – from autonomous vehicles, to predictive maintenance, to real-time travel information and traffic control. Across the sectors, technologies are converging to create a future for transportation that used to be reserved for science fiction.

As we show in our journal, the disruption cuts across every corner of travel and transportation – aerospace, rail, hospitality, manufacturing, and engineering – and has informed and empowered customers. While the job of technology is to make life easier, it has made doing business more challenging – if only to stay abreast of the constant change and decide which *revolution du jour* is worth your company’s attention.

So, welcome to our 2018 edition of **VELOCITY**. Enjoy the articles and research, and please follow up with our partners to discuss their implications for your business. At the back of the issue, you’ll find contact emails for the authors. We look forward to hearing from you.

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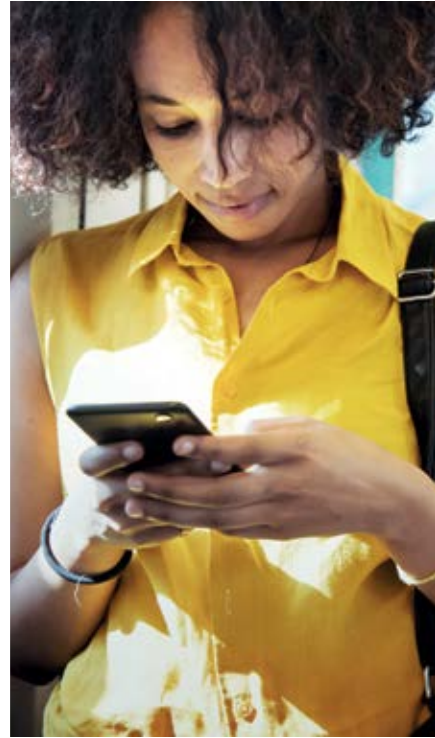
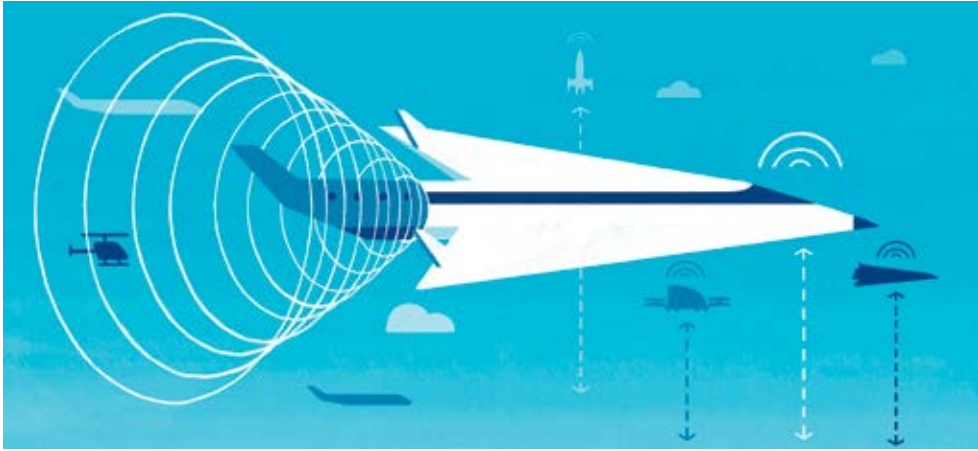
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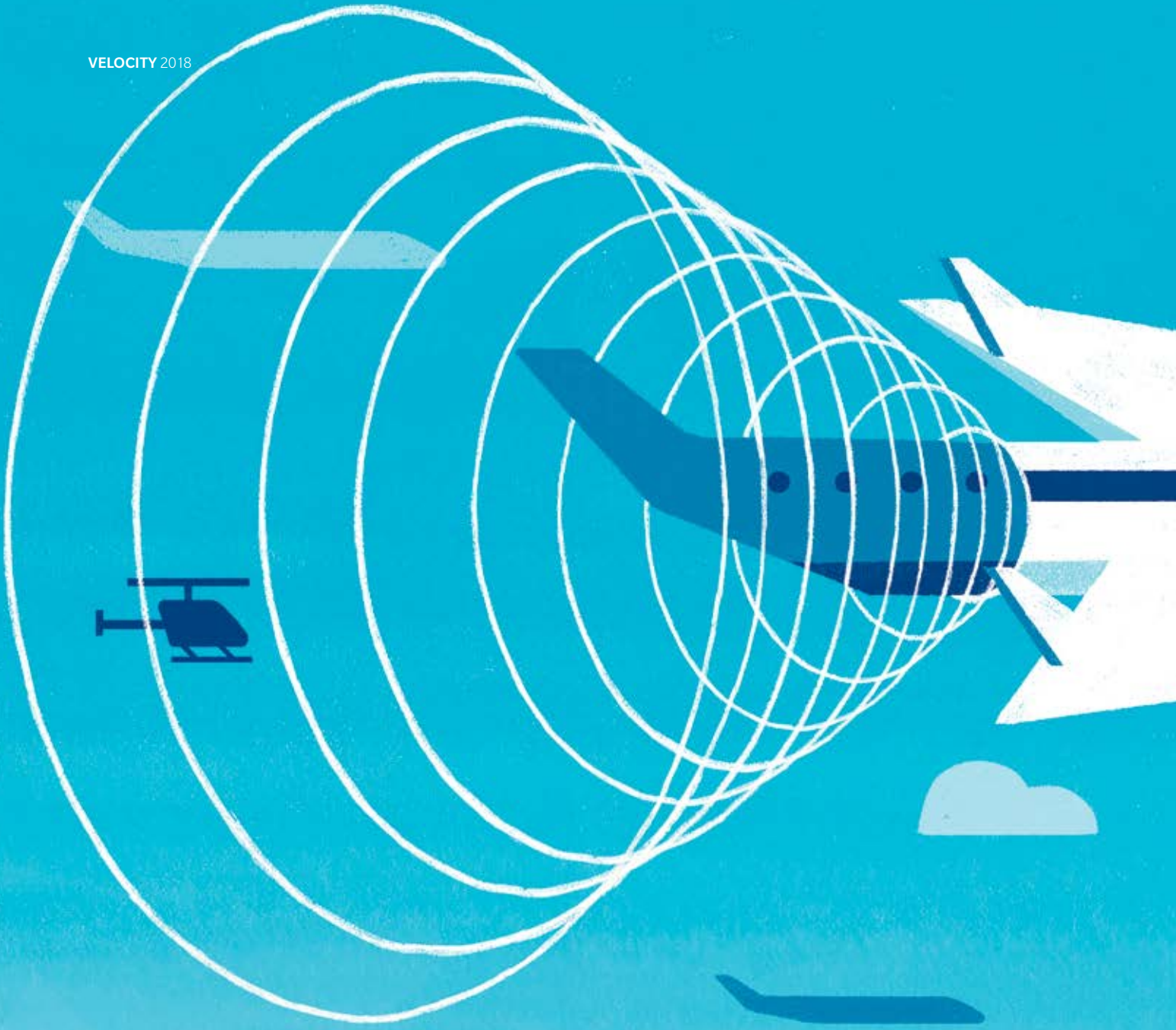
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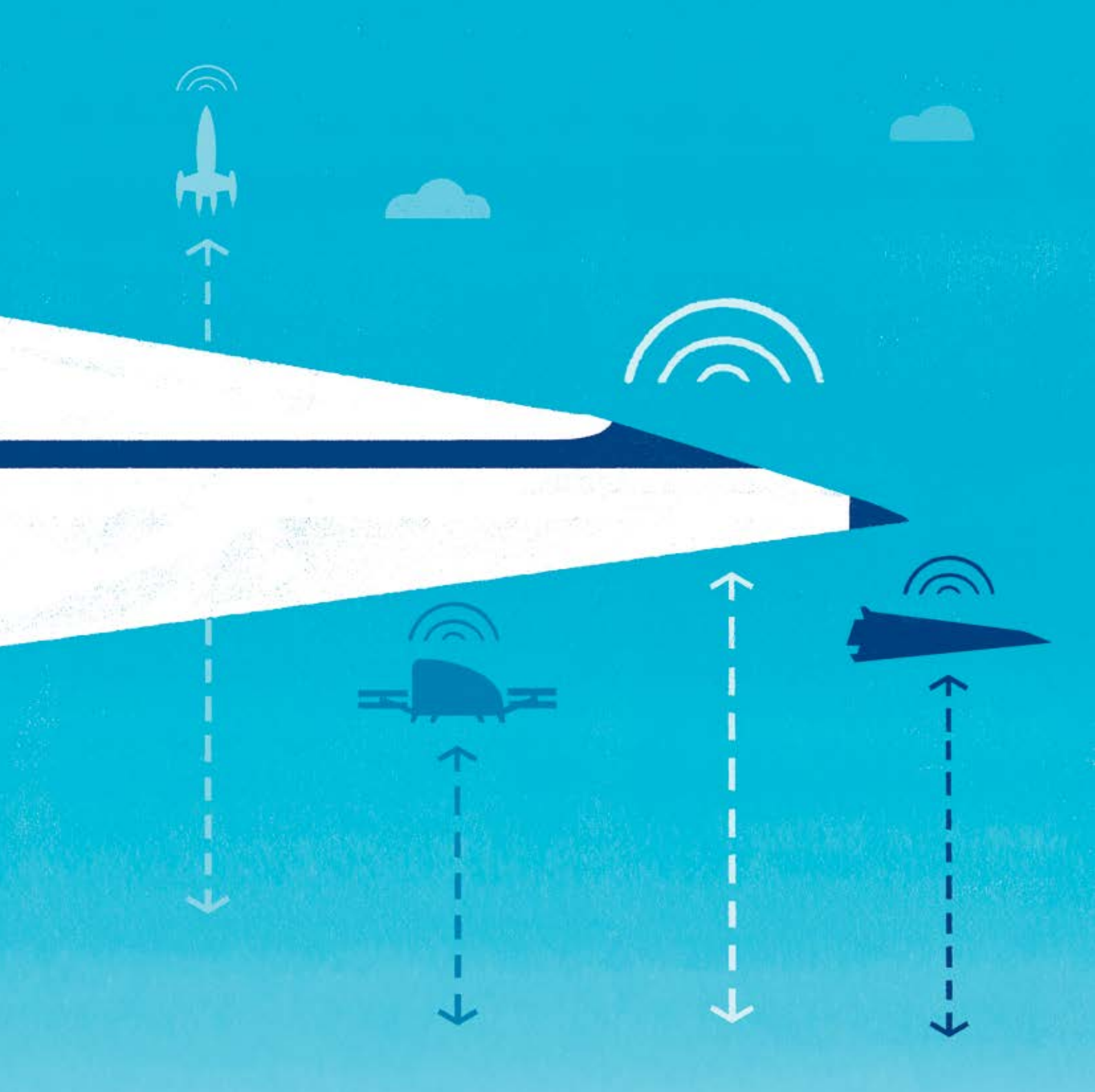
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A DECADE OF MEGA-DISRUPTION

How customer demands, digitalization, and a push for sustainable growth will transform aerospace

Jerome Bouchard • Geoff Murray • Lino Stoessel



WHEN IT COMES to technological and business disruption, the aerospace industry has had it comparatively easy over the past couple of decades. Aircraft got bigger and then smaller and always more efficient, but the way planes flew and the way they were manufactured remained essentially the same.

The economic climate confronting aerospace manufacturers was nothing like the tumult that rocked airlines since the beginning of the millennium, after a swarm of online travel agencies and price-comparison

websites brought pricing transparency to the sector. That upheaval, against the backdrop of the global financial meltdown, chipped away at carrier margins and customer relationships and unleashed a competitive onslaught that forced consolidation.

For aerospace, that period of relative calm is about to end as new technology and customer demands begin to reshape the industry's business model over the next decade. As this wave of mega-disruption sweeps the sector, aerospace manufacturers should heed a

The pressure is on for aircraft and engine makers to add more sensors to further enhance the real-time picture of what's happening with planes in flight

key lesson from the airlines: Incumbents must quickly embrace the big, bold ideas disruption brings – or else prepare to face off against faster-moving players.

A perfect storm

Perhaps mega-disruption may seem a bit dramatic, but the forces bringing change to aerospace over the next decade are all hitting simultaneously, compelling aircraft and component makers to overhaul their manufacturing and repair practices as well as their product lines. The three major categories of disruptors are digitalization, customer demand, and the need to achieve sustainable growth.

By itself, digitalization would be disruptive enough, involving the incorporation of technologies from predictive maintenance to autonomy. But sweeping the industry at the same time as other innovations such as 3-D printing and modular design means aerospace will not just be disrupted. It will be transformed.

Obviously, customer demand and achieving sustainable growth are perennials for aerospace – as for most industries. But over the next decade, customer demand will focus on reduced emissions and “green” operation, flexibility and innovation in cabin design, and development of technology that reduces travel time. Sustainable growth, on the other hand, will be concentrated in production line efficiency and agility, expansion into maintenance and other services, and innovative financing. Ultimately, all

three disruptor categories will lead to a new era of safer, more customized, fuel-efficient, and digitally optimized aircraft.

Growth and new rivals

Today, the aerospace industry is enjoying one of its most profitable periods, as economic growth in the developing world is helping to fuel unprecedented air travel demand and a global explosion in the size of the fleet and number of airports and hubs around the world. Already, airframe manufacturers have been producing record volumes of aircraft monthly. By 2028, there will be close to 38,000 aircraft in service, up from the current 26,000; the number of international hubs will increase to 80 from 60; and revenue passenger kilometers will be around 12 trillion (7.5 trillion revenue passenger miles) from the current 7.4 trillion (4.6 trillion revenue passenger miles).

The growth itself has become one of the disruptors. And while the barriers to entry in aerospace are considerable, based on the capital investment and expertise required, there are potential rivals in the wings looking to nibble off chunks of business.

For instance, China has begun developing its own aerospace industry under a national plan to become a global producer in several heavy industrial sectors by 2025. Though many consider it a decade away from being a real global competitor in aerospace, China has shown its ability to accelerate its entry into markets in other industries – including as an automaker and now the world's largest producer of electric vehicles and in solar panels, becoming the leading world producer in a matter of years, not decades.

The impact of digitalization

As it has in most industries, digitalization is reshaping aerospace – from the plethora of sensors constantly collecting data on board aircraft to eventually autonomous flight. Already, there is an uninterrupted flow of real-time information coming from aircraft updating ground operations and the pilots on the status of systems, equipment, and current and impending weather conditions. For instance, in the near future, these smart and connected planes will be able to adjust flight routes using real-time data to maximize fuel efficiency, minimize turbulence, and even eliminate the wait for the gate after landing.

One of the biggest challenges has been to gather and analyze the terabytes of data produced. Yet, the pressure is on for aircraft and engine makers to add more sensors to further enhance the real-time picture of what's happening with planes in flight – and on the

ground, where artificial intelligence is also starting to effect change.

In the maintenance end of the aerospace value chain, predictive maintenance – the process of using analytics to determine as precisely as possible when an aircraft’s part should be replaced – is increasingly demonstrating its ability to improve efficiency. While this approach to servicing planes has been available for several years, airlines and maintenance, repair, and overhaul operations are only just now embracing it to help ensure the full lifespan of parts is utilized, minimize the number of equipment checks, and maximize the safety of aircraft.

3-D and autonomy

Repair times also will become shorter thanks to 3-D printing of components – otherwise known as additive manufacturing. This will allow parts to be produced closer to where aircraft are being repaired. While more efficient, it’s apt to disrupt aerospace’s complicated global supply chain and potentially disintermediate certain players.

Longer term, the biggest digital disruption of all is likely to be single-pilot operations and even remote-controlled and autonomous aircraft with no

pilots on board. Gaining public acceptance of these advances may be challenging – even though both should enhance safety by minimizing human error.

Still, aircraft makers need to be prepared to build such aircraft eventually, as well as support the proliferation of autonomously functioning systems within aircraft right now. Aerospace giants like Boeing and Airbus have started divisions developing drones that will eventually taxi passengers around cities – with and without pilots. So too, however, have a bevy of digital giants and startups.

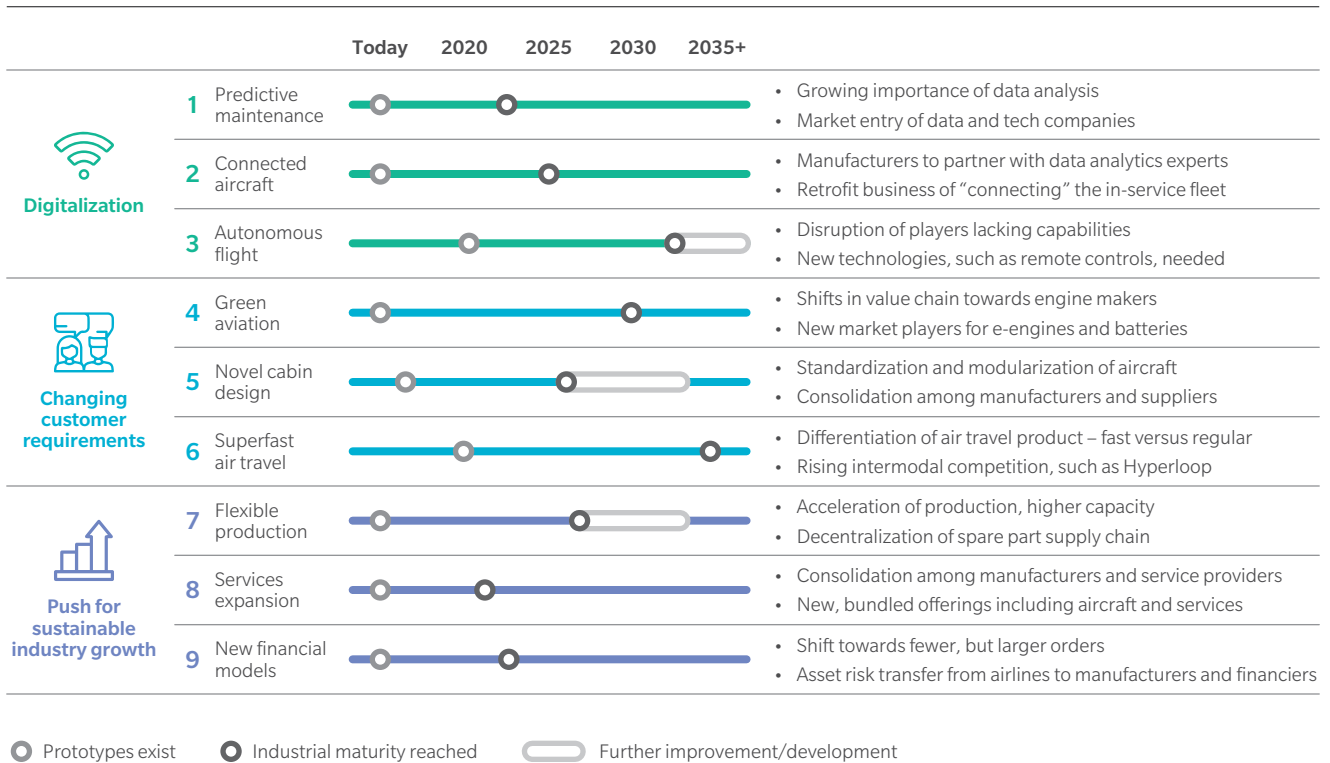
For passengers, much of aerospace’s digitalization should be a win, leading to more comfortable flights and less waiting because of delayed or canceled flights. While major changes like single-pilot or autonomous flight will be widely debated, much of the digital revolution will take place out of sight of travelers.

Meeting customer demands

Technology is not the only driver of disruption. Airlines and travelers are demanding change as well. In an effort to revive customer relationships, carriers are looking to manufacturers for ways to differentiate

THE SCHEDULES FOR DISRUPTION AND TECHNOLOGY WILL LINE UP

TECHNOLOGY MOVES QUICKLY THESE DAYS FROM PROTOTYPES TO FULL-FLEDGED ADOPTION



Source: NPR and Edison Research, Oliver Wyman analysis

the service they provide to travelers and attract new customers. One important factor will be ensuring the nonstop connectivity that digitalization also demands: Connected aircraft not only communicate their own status, but need to keep travelers online.

Airlines also want novel cabin design. Aircraft with modular interiors could enable airlines to reconfigure planes in real time to better utilize unfilled capacity. For example, if only 80 percent of seats are sold on a flight, one cabin section could be turned into working space for business passengers, a lounge, or even a kids' playroom.

Passengers and shareholders – not to mention some nations and their regulatory bodies – also are demanding airlines reduce their carbon footprint. Airlines are already working with regulators to increase fuel efficiency, but as a growing industry that generates significant greenhouse gases, aviation will be challenged to do more. Electric engines might be one solution; they come with the added benefit of reducing noise, making night flying viable. This would enable people to travel during more convenient times, reduce airport congestion, and greatly increase asset efficiency for airlines.

Finally, airlines and travelers also want faster flights and better connectivity to other travel modes. Perhaps this could mean supersonic flights from London to Sydney, a SpaceX rocket to get from Beijing to Rio de Janeiro in time for Carnival, or airports connected to city centers by hyperloop. While such long-term, attention-grabbing solutions generate a lot of buzz, they will need to balance the desire for speed with the need to reduce emissions and may require the development of new types of propulsion before they can be realized.

New business models

All this demand for change will inevitably impact the business models of manufacturers and force changes in the way they operate. Expansion into maintenance and service is an avenue aircraft and engine makers are already pursuing as a means of achieving sustainable and more predictable growth. But providing a full range of services and support requires manufacturers to consider new financial and ownership structures – such as leasing rather than selling planes – or offering bundles



of both product and services on a subscription basis. A bundle offered to an airline, for instance, might consist of leased aircraft, rapid maintenance, regular cabin changeouts, and relevant data feeds.

Aerospace manufacturers also will need to develop much more flexible and rapid production processes for aircraft, through the increased use of machine learning, robotics, and 3-D printing. As product development cycles shorten, manufacturers should be able to produce aircraft that are more responsive to changing customer needs. They also will be able to modify designs more quickly as new technologies arise in the future, such as the development of new jet fuels or propulsion systems.

Aerospace manufacturers may be fortunate that their decade of disruption is arriving during a period of growth and prosperity when they have the resources to implement change. It also is coming on the heels of disruption in many other industries, allowing aerospace to profit from the many lessons learned. And no doubt, the biggest lesson of all may be that the ultimate winners in

almost every industry end up being those already figuring out how to get ahead of disruption before it even starts.

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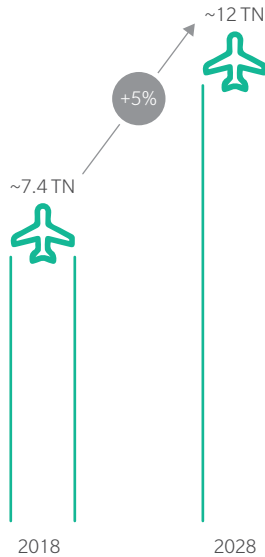
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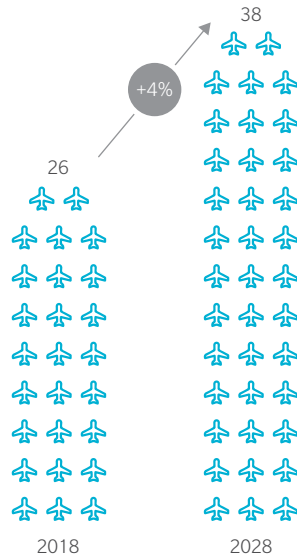
FOR AEROSPACE, IT WILL BE A DECADE OF MORE EVERYTHING

GLOBAL DEMAND IS UP; THE FLEET IS EXPANDING; THE NUMBER OF HUBS IS INCREASING

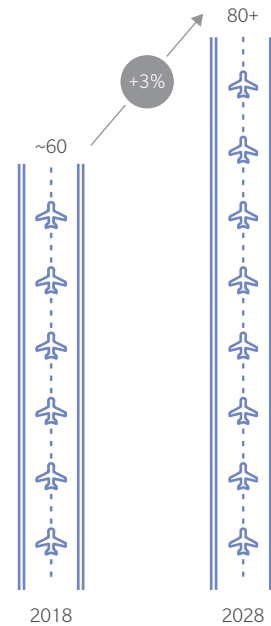
A growing air transport market...
RPK¹ in 2018 and 2028²



...requires more aircraft...
Global fleet in thousands, 2018 and 2028



...and more airports worldwide
Long-haul hubs³, 2018⁴ and 2028⁵



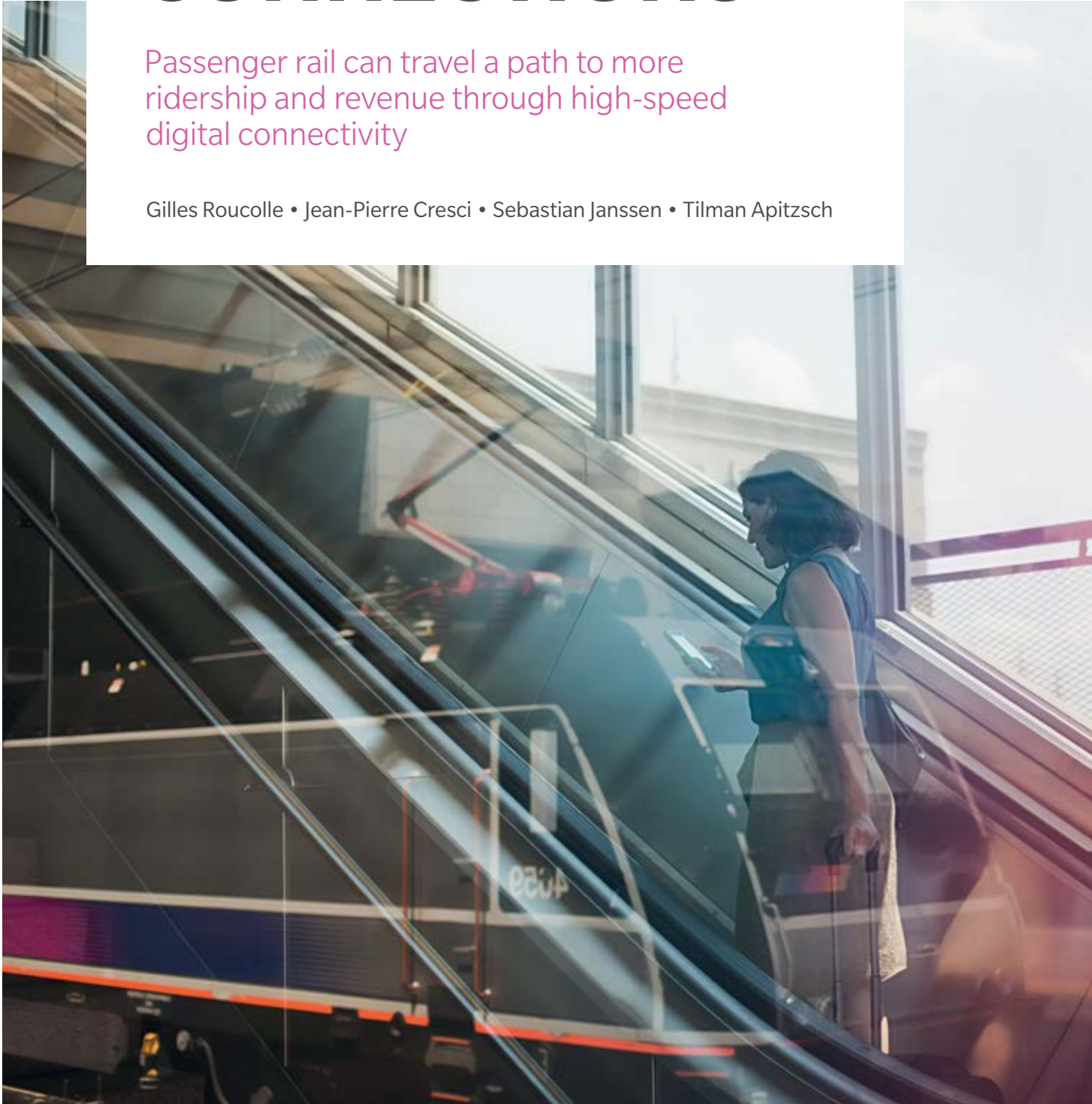
1. Revenue Passenger Kilometers, CAGR
 2. 2016 base extrapolated at Boeing Current Market Outlook CAGR of 4.7% (2017-2028)
 3. Cities with >10,000 long-haul passengers per day (international routes > 2,000nm)
 4. 2018 data estimated based on 2016 value of 58 airports
 5. 2028 forecast not available, 2026 data indicates 82 hubs

Source: Airbus Global Market Forecast 2017; Boeing Current Market Outlook 2017-2036; Oliver Wyman Fleet & MRO Forecast 2018-2028; Oliver Wyman analysis

MAKING THE RIGHT CONNECTIONS

Passenger rail can travel a path to more ridership and revenue through high-speed digital connectivity

Gilles Roucolle • Jean-Pierre Cresci • Sebastian Janssen • Tilman Apitzsch





CONNECTING TO THE CONSUMER: For rail and other modes of transportation, the path to the consumer's heart and wallet may be through digital services.

CONVENIENCE, COST, AND COMFORT used to be the three C's that explained why passengers chose one transportation option over another. In the 21st century, there's a fourth C that may trump all the others – connectivity. Today, many people can barely go five minutes without being connected to the internet whether through their smartphone, smartwatch, tablet, or laptop. Why should their time traveling be any different?

When it comes to transportation, consumers want more than just uninterrupted online access: They also want the ability to work, shop, text, tweet, tag, stream, or catch up on the news while cooped up in a train, plane, bus, or car – just as they would when not on the move. Because they're traveling, they especially want fast, flexible, door-to-door trip planning and booking, as well as real-time travel information – any service that will save them time and make their journey more productive and enjoyable.

It should come as no surprise that the future growth in ridership and revenue will go to the mode of transportation that proves best at providing what travelers want in connectivity and digital services. And while passenger rail has often trailed aviation, automotive, and bus rivals in offering internet, some of its leading brands – along with some key technology players – are starting to invest in strategies that should help trains get a bigger share of the smart-mobility wave.

Connectivity and 5G

No doubt, rail – whether intercity, commuter rail, or urban transit – faces a challenge providing dependable wireless as trains travel at high speeds through tunnels, underground, and areas with few mobile broadband towers. During rush hours, railcars can carry densities exceeding those of typical offices, which means a lot of competition for bandwidth. All this has often left rail passengers restricted to texting and sending emails, forgoing activities like streaming that become fraught with annoying buffering.

Today, rail manufacturers and operators, often in partnership with technology companies, are testing possible solutions – even though some contend things won't really improve for rail until the arrival of ultra-high-speed, ultra-high-capacity wireless 5G networks. In the United Kingdom, networking hardware giant Cisco has been working with ScotRail on what is billed as the world's fastest train Wi-Fi. The pilot program on the Glasgow-to-Edinburgh line has reportedly reached 600 megabits per second in trials.

Virgin Rail trains are trying to get around this problem by offering BEAM service, a free app that allows passengers to use onboard servers to stream television shows and movies and access newspapers, magazines,

and games on smartphones and laptops. That’s an improvement, but not a long-term solution.

French railroad SNCF has installed about 18,000 antennas on a fleet of 300 trains, along with 4G towers every three kilometers, to provide coverage for much of its high-speed TGV passenger rail network. It is also in the process of rolling out 4G on regional and suburban trains.

But 5G may not be that far off. In Japan, 5G is already being tested on high-speed trains in preparation for the 2020 Olympics in Tokyo.

No digital services, no go

Ultimately, given the importance of digital services and connectivity to travelers, passenger rail services will have no choice except to upgrade to full internet access. In a recent Oliver Wyman five-nation survey to assess how far travelers would go for access to a wide array of digital services, consumers indicated they would willingly switch from their current means of travel and even pay more for the convenience. (See “The World Wants Smart Mobility” on page 26.)

Why not? Online access and digital services make the time on the train more productive for working passengers and more enjoyable for everyone. Following through on that concept, Deutsche Bahn has created

an “Idea Train” (Ideenzug) that features a fitness studio, meeting space, and gaming consoles. This vision for rail suggests that trains have the potential to become extensions of office and home – like what Starbucks coffeehouses and internet cafes represent to younger generations and workers who freelance or work remotely.

Offering these kinds of experiences, especially to millennials and Generation Z passengers who are less interested in cars and driving than their parents, could create a competitive edge for trains over planes, given aviation’s time-consuming security and periods in flight when cellular devices must be turned off; over buses, given the ability on a train to walk around and its higher degree of comfort and amenities; and over cars, given the current requirement that drivers focus on the road. While a future of autonomous cars may portend a threat to rail ridership, driving – even hands-free driving – still means the hassles of car ownership, traffic congestion, and parking.

Fast payback

While a new image for rail won’t come easy or cheap, the investment in connectivity is likely to elicit a quick return from increased ridership and new sources of revenue – either from the direct sale of digital services

RAIL COMPANIES AND MANY OTHERS ARE LINING UP TO SUPPLY SERVICES BASED ON RESULTS IN FIVE COUNTRIES FOR OLIVER WYMAN’S MOBILITY 2040 SURVEY

	Global	Germany	France	USA	Italy	China
Financial/Insurance services						
Multimodal door-to-door travel planning						
First/last-mile services						
Safety						
Real-time information						
Entertainment						
Work and education						

Transport operators
 Digital giants
 Financial institutions
 Media providers
 Innovative startups
 Not sure

Source: Oliver Wyman Mobility 2040: Smart Mobility survey; Oliver Wyman analysis

onboard or from the ability to maintain profitable ticket pricing made possible by these new services. In Australia, the Victorian government's Regional Rail Connectivity Project expects to roll out mobile signal boosters across the V/Line Vlocity train fleet and is building 35 mobile towers, in partnership with several telecoms. While the project is costing AU\$18 million, the enhanced connectivity is projected to add AU\$20 million annually to the state's economy.

Apps offer another quick-turnaround potential for rail as operators begin digital engagement with customers – even though it's increasingly difficult to secure real estate on customers' busy mobile devices. Besides making life more convenient for travelers, apps provide a constant feed of data to the company about consumer preferences and behavior.

Although Deutsche Bahn is primarily a rail company, it cleverly helped start Quixxit, a popular train, bus, and flight planning app. In France, SNCF is realizing new revenue from its mobile app, which lets passengers book connections and trips as well as reserve taxis and rental cars before reaching the station. Onboard food and drink can also be ordered up from the train's bar-restaurant.

Not surprisingly, tech competitors recognize the possibilities. One of the most potent rivals is Moovit, an urban mobility app that provides real-time, crowd-sourced transport information. Among its investors: Intel and BMW.

Collaboration and partnerships between rail and non-rail players, such as telecoms, tech startups, retailers and e-commerce companies, are also part of this transformation. Even the same car-sharing services that are partially responsible for the drop in urban transit ridership are likely partners. For example, Amtrak, the US intercity passenger train operator, is partnering with ride-share company Lyft to help passengers get to and from stations, using Amtrak's app to book the car. Train operators could also pair up with entertainment companies to provide on-demand movies or educational institutions to offer courses or lectures.

Special delivery

In this vision for trains, stations become integrated transport hubs, using smartphone apps to facilitate door-to-door travel options. Train stations in several cities are working with a Deutsche Bahn subsidiary that is testing on-demand, driverless shuttle buses for passengers traveling to or from the station.

Making train stations convenient and fun destinations – with top-tier retail, restaurants, and even cultural events – could help push up ridership. SNCF, for example, is partnering with e-commerce giant Amazon to add smart lockers at 980 French train stations, allowing busy commuters to place an order

The new vision for rail suggests trains have the potential to become extensions of office and home – similar to what Starbucks coffeehouses and internet cafes mean to younger generations

one day and pick up their packages the next. And London's magnificently renovated St. Pancras station provides everything a traveler needs in one spot. Its St.P app offers real-time travel info, directions to station and city attractions, and exclusive, targeted retail deals for travelers.

In the end, the passenger rail industry should be prepared to make investments and look beyond its traditional role. First and foremost, rail must figure out how to get hyper-connected today if it ever wants to be the first choice of travelers.

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THE HURDLES DRONES FACE

Regulators grapple with the risks of autonomous flight as they work to incorporate drones into commerce and the airspace

Dave Marcontell • Steve Douglas • Guillaume Thibault • Robbie Bourke



THE WORLD OF AVIATION and aerospace is on the cusp of a revolution based on autonomous flight and drone technology. While today's drones are used for such tasks as inspecting tracks or power lines and assessing wildfires, tomorrow's larger models will transform industries like construction and retail by carrying heavy cargoes to hard-to-reach places. In less than a decade, traffic congestion and urban pollution could be eased by electric unmanned aircraft transporting people or products around cities.

Yet, reaching that potential will take new regulation and most likely advances in technology to enhance safe operation. Despite the business community's impatience with what is seen as a go-slow approach to drones, a failure to sufficiently test and validate these rapidly emerging technologies could doom that blossoming revolution with the first loss of life from a drone mishap. Before the technology can be embraced for extensive commercial use, the risks – especially from bigger drones – must be identified, and strategies to mitigate those hazards must be developed.

A world of no

Where do we stand today? In the United States at least, most federal regulations on drones restrict their use: Drones, or unmanned aircraft systems (UAS), cannot fly over most federal facilities or over people; drones cannot fly at night or within five miles of an airport without permission; drones must fly below 400 feet and at less than 100 miles per hour; with some exceptions, they must weigh under 55 pounds (25 kilograms); and they must yield the right of way to manned aircraft. Some states further prohibit the use of drones in hunting; in


California, drones cannot be used to record another person without getting consent. And in probably the most limiting regulation when it comes to the widespread commercial use of drones, they must be kept in the operators' line of sight at all times.

Recently, a congressionally mandated report from the National Academies of Sciences, Engineering, and Medicine chided the Federal Aviation Administration (FAA), the primary regulator for UAS, for focusing on the risks posed by drones instead of their potential benefits. "Fear of making a mistake drives a risk culture at the FAA that is too often overly conservative, particularly [with] UAS technologies," the National Academies report concluded.

Most drone proponents want regulation relaxed on flying small drones beyond the limit of sight. Here, the Academies' criticism may have some validity, as there can be no substantial commercial application if businesses must request permission from the FAA each time they want to fly beyond an operator's line of sight. Given that drones are essentially relegated to sparsely populated locations, the FAA could consider a partial relaxation in cases involving the typical under-55-pound drone.

Operating blind and big

Broader regulation mandating that all aircraft be able to see and avoid other aircraft, however, prevents the agency from a total elimination of the line-of-sight rule. Drones operate without human pilots, so they cannot comply. Currently, the Volpe Center, a research unit within the US Department of Transportation, is developing a radar system that would enable remotely



ENTERING THE CITY: Drones are on the periphery right now. But government and business are working to make them part of the economy.

piloted aircraft to detect and avoid traffic at a level of safety equivalent to the see-and-avoid capability of manned aircraft. But until something like that is developed, an across-the-board repeal of the rule seems imprudent at best.

Another set of risks that the FAA and regulators worldwide must consider involves drone size. While there are a lot of interesting uses with sensor technologies and video on smaller UAS, drones almost certainly will have to grow well beyond 55 pounds to have any real commercial and logistical value. Yet, it would be unacceptable from a public safety standpoint to simply remove that prohibition without considering – and mitigating – the risks inherent with large drones.

If a small, battery-powered drone falls out of the sky, particularly now when they are barred from operating in populated areas, the risk is minimal. That will change dramatically if big UAS begin to travel long distances and run on fuel. To carry multiple packages for delivery services or move heavy equipment, drones will need to be similar in size to today’s military drones, which can weigh almost 5,000 pounds. At that size, a drone falling to the ground in a crash could destroy a building and pose a lethal threat to anyone in its way.

Airworthy enough for people

There is also the inevitable question of human transport with drones. As urban areas expand and

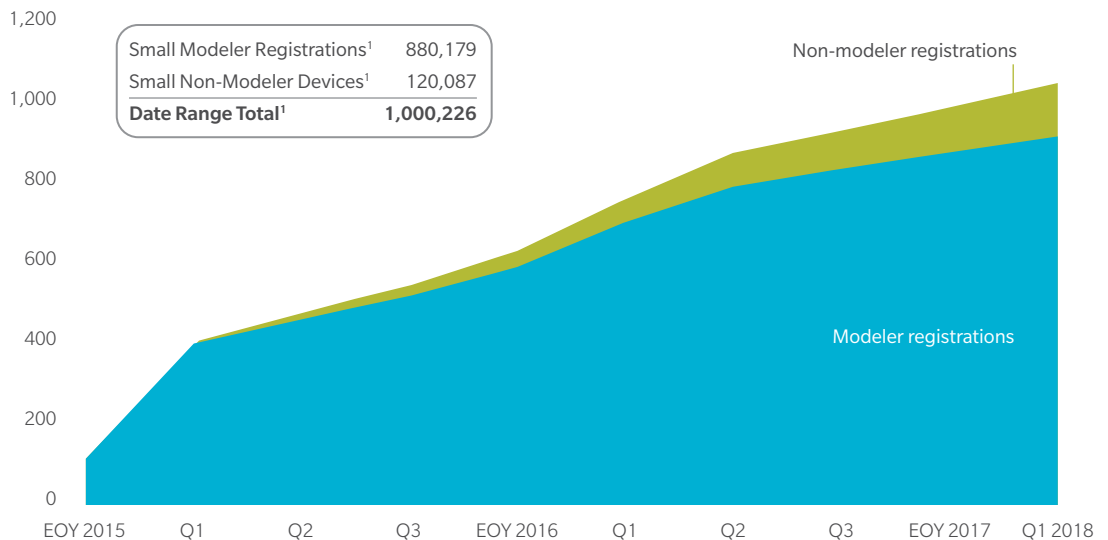
ground congestion intensifies, the economic case for pilotless air taxis gets stronger. Uber Elevate, among others, is pursuing this vision aggressively. Yet, a large drone carrying one or two passengers raises the risk factor exponentially.

It is not difficult to build an all-electric vertical takeoff and landing (eVTOL) aircraft that can carry passengers – there are about 50 prototypes of these air taxis worldwide. The challenge is figuring out how to raise drone design reliability standards to be more akin to those of commercial aviation, in which a system failure is tolerated every one billion hours of flight. Bigger drones raise questions of airworthiness and reliability that go far beyond the standards that apply in the consumer electronics world of drone hobbyists.

Current commercial drones have a significantly worse record for failure-free performance. For example, 15 percent of new micro-drones sold today have bugs that will ground them within six months. Regardless of the demand and potential for drones, regulators would be very unlikely to sign off on vehicles with such a low standard of airworthiness.

The history of urban helicopter commuting provides a lesson on the outcry that follows accidents. In 1977, a helicopter landing on the heliport atop the 59-story Pan Am Building in midtown Manhattan flipped over, killing four passengers waiting to board and a pedestrian on the ground. The crash led to the shuttering of the helipad, bankrupted the operator, and essentially doomed widespread urban helicopter transport ever since.

BY THE BEGINNING OF 2018, TOTAL DRONE REGISTRATIONS WITH THE FAA HAD TOPPED ONE MILLION
THE FAA EXPECTS REGISTRATIONS TO TOP THREE MILLION BY 2022 (IN THOUSANDS)



1. Cumulative FAA registrations of modeler (hobbyist) and non-modeler including commercial and research drones as of January 18, 2018
Source: US Federal Aviation Administration, Oliver Wyman analysis

Then, there is the possibility of cyber terrorism, which applies to both large and small drones. Like any digital system, drones and their control systems can be hacked, and the FAA will have to incorporate IT security and redundancy mandates to reduce the hackability of drones as part of any certification standards the agency develops.

Controlling proliferation

Finally, the FAA must consider how to regulate the various players using drones, preventing an operator, for instance, from flying a drone in airspace where it poses a risk to the public. For this, technology may need to be developed that could take control of a drone, if it flies outside approved air space, and bring it down in a controlled manner.

Even without a fully developed definition of how drones fit into the national airspace, they are rapidly proliferating. At the end of last year, the FAA registry for drones topped one million. More than 800,000 of these are registered to hobbyists, the rest to businesses. The FAA projects that by 2022, the number of registered drones will soar above 3.8 million. That makes for an increasingly crowded sky, substantially raising the risk of collisions.

Recently, 10 federally sponsored projects were selected to explore what regulations make sense for drones – testing everything from mosquito control in Florida, to medical equipment delivery in Nevada, to food delivery in California. For these projects, the FAA has waived current restrictions on drone use so the companies can provide it with data that will help shape a certification process and new rules. Among the companies involved in these pilot programs: Alphabet's Project Wing, Flirtey, Airbus, Apple, AT&T, Intel, Microsoft, and Uber.

That said, rulemaking is a slow, measured process. It may be five years before US regulations support the widespread use of drones in everyday commerce.

Meanwhile, in the EU

The economic stakes are high. In the European Union, research by the public-private partnership SESAR (for Single European Sky Air Traffic Management Research) shows that the rapidly developing drone sector could account for 10 percent of the EU's aviation market by 2050 – about €15 billion a year and 150,000 jobs. Currently, drones are regulated by the European Aviation Safety Agency (EASA) and various national regulators, depending on drone size. But the EU is working to unify its rules, as differences from country to country complicate cross-border trade and provide uneven levels of safety. Under a recent compromise, the European

Commission and EASA will take the lead in rulemaking for a European drone ecosystem, expected to be finished in 2019.

While the debate over drone regulation is in its early stages, there's little doubt there will be a Grand Canyon-size gap between what industry would like in certification standards and what the FAA and other regulators are willing to approve. As it is, tech companies and startups experimenting with drone technology have moved research operations out of the United States to places like Dubai where regulations are less stringent.

In the end, a new category of air operator may emerge – companies that are certified and approved to operate larger drones. Here, the numbers will not be in the hundreds of thousands but more likely in the hundreds. And that transition – from an open-access system of ownership and operation to one with similar controls and barriers to entry as aviation and aerospace manufacturing – may be tumultuous as companies vie for what is currently an elusive standard of certification.

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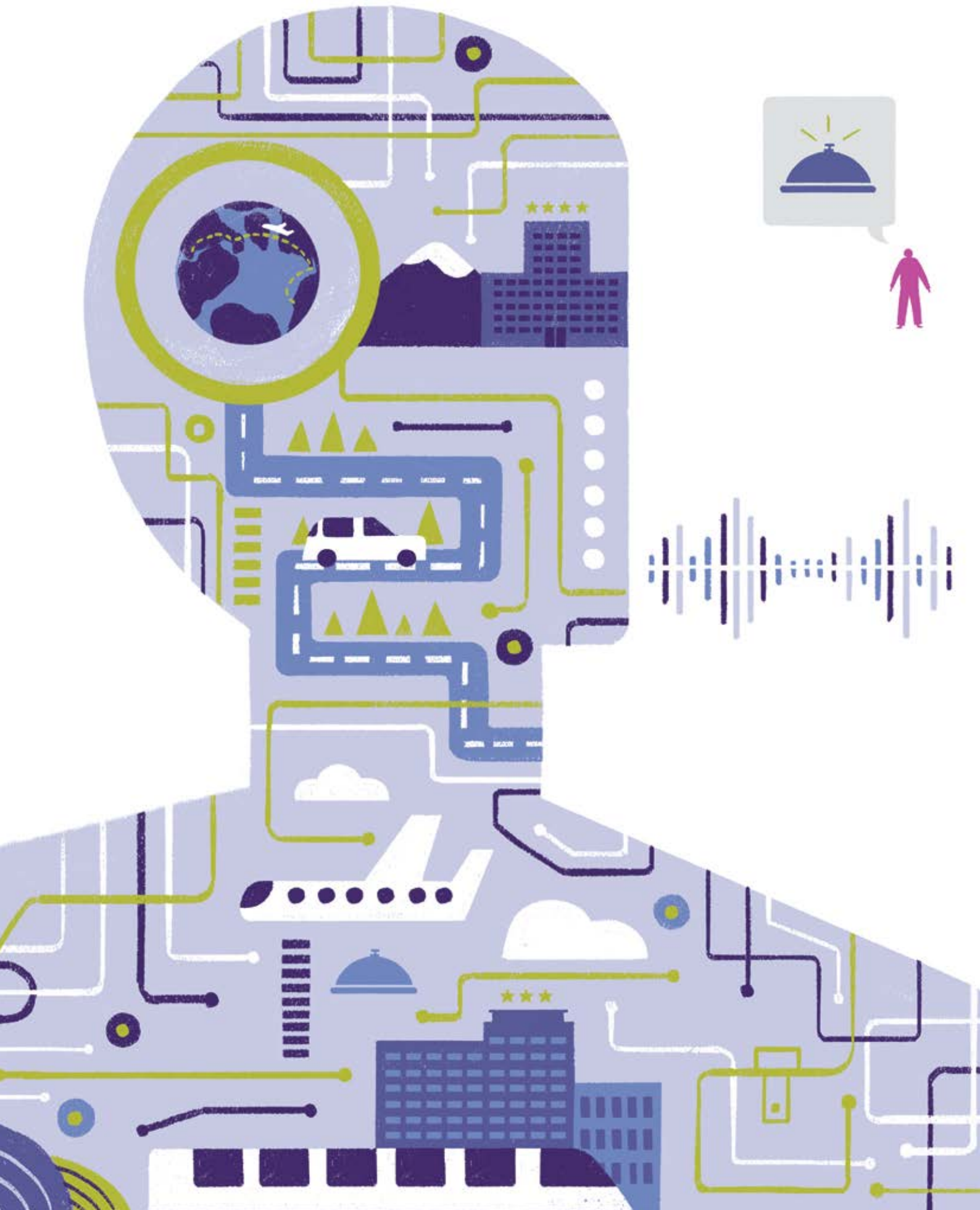
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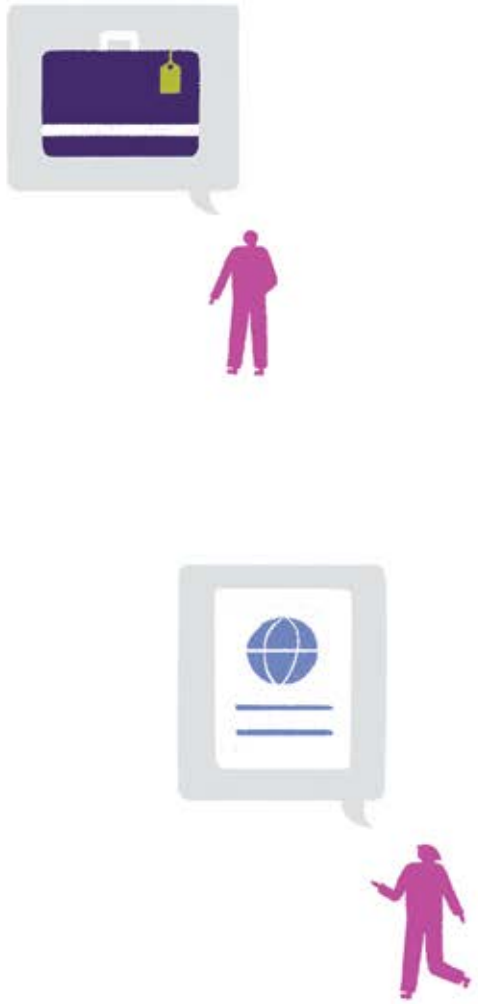
This article originally appeared in Forbes on September 10, 2018.



HOW SMART SPEAKERS WILL REINVENT TRAVEL

The winners will be those who recognize early the technology's power and consumer appeal

Scot Hornick • Shri Santhanam • Scott Boland-Krouse • Alex Hill



MARRIOTT RECENTLY TEAMED UP with Amazon to offer a hospitality version of the e-commerce giant's Echo devices in select hotel rooms. Now, when guests want to order room service or housekeeping, they can simply ask Alexa, the voice of their disembodied personal concierge. Travelers with an Alexa device at home can book a car rental or hotel through Expedia and Kayak. Similarly, Google Assistant, which can be used via Google Home devices, smartphones, or smartwatches, can track flight prices and status, suggest nearby restaurants, convert currency, give directions, and provide same-day updates on traffic to airports. People can even book flights through voice-enabled Google Search.

On many fronts, artificial intelligence-powered smart speakers and apps seem poised to become the world's virtual travel agents. Virtual personal assistants like Alexa are moving rapidly from nifty gadgets for techies to household appliances and mobile devices ingrained in everyday life. The adoption of smart speakers is even outpacing that of smartphones a decade ago: An NPR-Edison Research study found that 18 percent of adults in the United States, or 43 million people, now own a smart speaker. Worldwide, ownership exceeds 100 million units and is projected to reach 225 million by 2020.

If consumers start turning regularly to smart speakers for their travel needs, they could end up interacting less and less with traditional airline, hotel, and even online travel agency brands. Or, if travel companies are paying attention, such voice-enabled devices could provide brands with a new front door to the customer. As happened with the rise of the internet and mobile apps, winners and losers in

the age of conversational AI will be determined by whether companies recognize its potential early and act on it.

Most vulnerable

Possibly most at risk in the travel community are some of the most digitally savvy players in the space – online travel agencies like Expedia and Booking.com. Several have already established partnerships with Amazon, and they all have relationships with Google through search. Their first move will be along the lines of what they did when mobile emerged as a powerful channel – they created apps and acted quickly to make sure consumers followed them onto the new device. Yet, more so than traditional travel providers, these companies face possible disintermediation by smart speakers, which will be capable of aggregating potential travel options on command. Virtual personal assistants may be able to do this even better than online agencies, given the amount of personal data about customers that the big tech companies will have at their disposal.

For airlines, hotels, rental car agencies, and the like, the challenge should not prove as disruptive, unless we foresee the rise of Google airlines or Amazon hotels – prospects that, while possible, are unlikely to generate the returns on capital that the tech giants are used to. The hurdle for traditional providers will be defending their margins, brand, and relationships with customers – challenges they already have had to battle at the hands of online travel agencies. Below, we examine three strategies that should not only keep traditional travel companies connected with customers, but which also may lead to a healthier industry and a better travel experience overall – partnering with Amazon and Google, leveraging loyalty programs, and adapting content while protecting branded search.

Strategic partnerships

Considering the speed of smart-speaker adoption, travel providers have a relatively small window in which they still have the leverage to negotiate common ground with the likes of Google and Amazon. Participating in the earliest wave of partnerships should be an advantage, as provider clout will be strongest before a substantial portion of consumers start using Alexa and Google Assistant to plan and book their trips. While tech giants already have some travel-related data from searches and purchase history, the more they can add to their databases over time through travel queries and transactions, the harder it becomes for travel providers to extract favorable terms.

Amazon and Google each offer different advantages as partners. Amazon, for instance, is the undisputed

leader in sales of personal assistants, with a 72 percent share of the market, according to a March Voicebot Smart Speaker Consumer Adoption Report. Google has its extensive search capability and a desire to catch up with Amazon. Both would like to supplant the online travel agencies as the go-to intermediary for travel.

Travel companies would like to increase brand awareness and reduce their exposure to escalating online agency commissions on bookings. Today, those commissions can range as high as 30 percent for smaller providers and others with less bargaining power to rates in the low teens for large brand-name hotel chains.

While travel companies could play one tech giant against the other to get the best deal possible, more likely they will conclude that working with both makes the most sense. In either case, travel providers need to keep two goals in mind: retain and enhance access to the customer and maintain control of the customer's data. For instance, even when using Alexa or Google Assistant to execute a booking, hotels and airlines should negotiate agreements that, for a referral fee, let them complete transactions through their in-house channels. While Google and Amazon may not embrace this enthusiastically in the case of smaller brands, the extra fee should allow larger brands to continue to directly serve customers.

Make loyalty count

Loyalty programs represent a treasure trove of data – one that travel companies are only beginning to exploit effectively to get closer to their customers. They also may provide airlines, hotel chains, and rental car companies more clout when setting up smart-speaker partnerships.

By offering special rewards and discounts to loyalty program customers through smart-speaker channels, travel brands could accelerate adoption of voice-enabled systems, making their partnerships valuable to Amazon and Google. The stronger the loyalty program – and the more trust customers have in the brand – the more leverage they gain with their members and in negotiations to maintain control over customer data and access.

As connoisseurs of data, Google and Amazon will recognize that loyalty programs produce substantially more detailed portraits of member preferences and behaviors than they can get from their miscellaneous purchases and searches. Still, travel companies should be cautious and carefully weigh the benefits of sharing data. It will be a delicate balancing act: While the inclination will be for travel companies to circle the wagons around their data, the more information they provide smart-speaker algorithms, the better they can fulfill a customer's query and the more satisfaction customers will derive from the new channel.

Smart-speaker companies may also create their own loyalty programs, à la Amazon Prime, in an effort to collect more travel-specific data on their own.

Adapt to verbal search

Over time, smart speakers will be less about the device and more about the technology that allows consumers to talk to any device. Travel providers, like most consumer-facing companies, need to start thinking about crafting content that reflects that reality. For instance, travel companies should consider making their current Apple and Android apps voice-enabled or adding branded “skills” that can be loaded onto Alexa. Presumably, this means partnering with a provider of that technology – and the best choice may be the one that is the most mobile. Indeed, Apple already offers a Siri software development kit to allow app developers to tie into its smart assistant technology.

In the age of Alexa and Google Assistant, branded search terms could also become even more important than they are now. How many times does the waiter at your favorite restaurant get to the end of the specials, and you no longer remember the first one? Listening to a voice search can pose a similar challenge when you’re asking about hotel or flight choices. Google has found that online searches with branded keywords have a conversion rate – turning a search into a transaction – over two times higher than searches without them. So, encouraging branded voice search should become a priority. One can imagine hotel chains or airlines providing discounts or loyalty-point bonuses to customers who use a brand in a conversational AI query, such as “book me a flight on Southwest to Dallas Tuesday night.” Providing added inducements to use

voice channels and branded search should reinforce loyalty programs and the brand’s identity.

Smart speakers, still in the toddler stage as far as the development of the technology, mark the beginning of a new voice-enabled era of travel. Although travel providers have not led the pack on customer technology interfaces thus far, they now have another opportunity, with a particularly consumer-friendly technology, to change their image. They should seize it.

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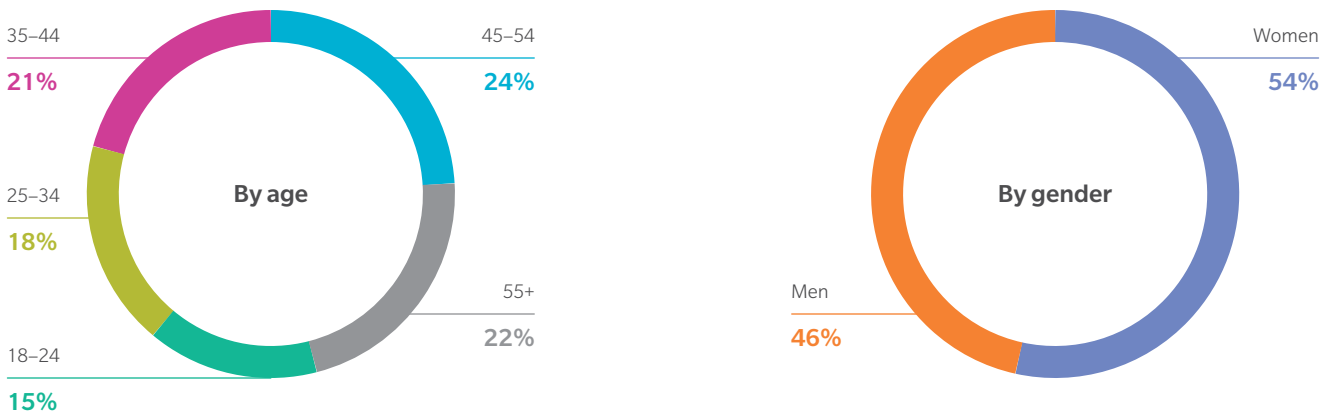
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This article first appeared in Harvard Business Review on August 7, 2018.

43 MILLION ADULTS IN THE UNITED STATES OWN SMART SPEAKERS



Source: NPR and Edison Research

MEET THE NEW “MADE IN CHINA”

Why China's latest aspirations should make aerospace and Western manufacturers nervous

Jerome Bouchard • Matthieu Barbiery



WHEN A TWO-YEAR-OLD Chinese startup unveiled the Byton – a high-end, artificially intelligent, fully electric sport utility vehicle that is 40 percent cheaper than a Tesla Model X – at this year’s Consumer Electronics Show (CES), it threw down the gauntlet in the race to develop “intelligent” electric cars. The move signaled that Chinese manufacturing has entered a new phase.

Already among the world’s largest producers of personal computers, solar panels, and integrated circuits, China is also quickly becoming a major supplier in aerospace, electric cars, and robotics. Until now, Chinese producers have been held back from entering

these sectors in large part because of concerns over quality and safety. But the fact that Future Mobility Corp. was able to poach some of the biggest names in tech and electric vehicles from companies like BMW, Google, and even Tesla to develop the Byton shows how quickly the landscape can change and how Western companies cannot afford to be complacent.

The Byton has the financial muscle of the nation’s “Made in China 2025” initiative behind it. The 10-year program is dedicated to help China take on top-tier manufacturers in the United States, Europe, and Japan in industrial sectors once considered too technologically



ON THE ASSEMBLY LINE: A worker turns his attention to an auto frame – part of China’s global push into industrial products like cars and jets.

sophisticated for low-cost, mass production, like robotics, biopharma and advanced medical equipment, aerospace, power generation, and rail.

Chinese momentum

China’s ambitions to transform itself into a leading manufacturing power has been greeted thus far by an astounding lack of concern, or even curiosity, among European and US industrial incumbents. To be sure, Chinese electric cars have been unveiled in the past and not made it beyond China, the biggest market for EVs in the world. Worse, some have ended up in bankruptcy. Nonetheless, the Byton, which is said to be aiming for a production of around 300,000, has global ambitions and demonstrates China’s capacity and unwavering determination to make it happen – perhaps well before 2025 in some sectors. And with Guangzhou Automobile Group still rumored to be eyeing a bid for Fiat-Chrysler and showing up at the North American International Auto Show in Detroit this year with a new electric car aimed at digital natives, it’s clear that China is pushing forward.

This means that Western manufacturers owe it to their stakeholders to prepare strategies, including increased investment in research and development, to fend off the threat of a new lower-cost competitor on their turf. And that preparation needs to begin now, not after China has launched products that match and surpass the West’s. To wait would create a situation

reminiscent of Japan’s battering of the US auto industry in the 1970s when Detroit ignored the success of small cars and kept producing gas-guzzling behemoths.

When companies have national and provincial support and access to low-cost capital, things happen quickly. Beginning in 2007, China provided as much as \$18 billion in cheap capital for its then-fledgling solar panel industry. By 2012, major European and US solar panel manufacturers were filing anti-dumping challenges; by 2015, seven of the top 10 solar-panel manufacturers were Chinese, and China controlled almost half of the photovoltaic solar market.

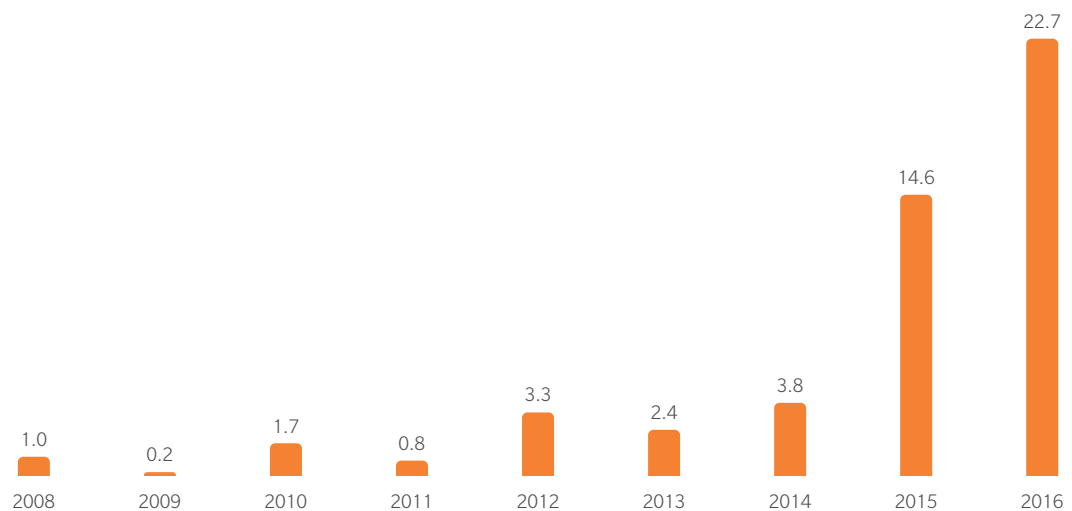
More M&A deals

As China pushes forward with “Made in China 2025,” it is pursuing strategic mergers and acquisitions, buying up Western operations to expand its presence in these manufacturing industries, and acquiring proprietary technology. In Europe alone, the value of Chinese M&A deals in aerospace, automotive, electronics, and machinery jumped from \$3.8 billion in 2014 (before the “Made in China” initiative was launched) to \$14.6 billion in 2015, and more than \$22 billion in 2016.

Recently, the Chinese group Midea acquired German robot manufacturer Kuka, an illustration of how China is actively buying technology it sees as critical. Midea committed to maintain Kuka’s headquarters in Germany and support Kuka’s development strategy until 2023. Nevertheless, Kuka’s

CHINESE ACQUISITIONS IN EUROPE TAKE OFF AFTER “MADE IN CHINA 2025” IS ANNOUNCED

ANNUAL INVESTMENT IN AEROSPACE, AUTOMOTIVE, ELECTRONICS AND MACHINERY SECTORS (IN BILLIONS OF US DOLLARS)



Source: Dealogic, completed or pending deals

intellectual property remains at risk over the long term as does Germany's strategic position in the robotics industry.

China's state-owned enterprises (SOE) also are consolidating to achieve size and brand recognition and acquire critical technology. For instance, in June 2015, China Railway Rolling Stock Corp. was created from two SOEs and became the largest rolling stock manufacturer in the world. Similarly, in August 2016, Aviation Industry Corporation of China and Commercial Aircraft Corporation of China joined forces with the Chinese government to set up Aero Engine Corporation of China.

Jets made in China

With Aero Engine, China hopes to accelerate the development of indigenous commercial aircraft engine and aircraft production and eventually build an industry. Here, China bumps into stringent global safety regulations and certification requirements that pose sizable hurdles its manufacturers have yet to overcome.

Still, China has leverage from the size of its domestic market, which on its own can sustain substantial production. And in the case of any "Made in China" industry, there's always the possibility of regulatory measures against foreign competitors, especially given the rise of protectionism worldwide.

The potential for disruption from "Made in China 2025" is great, and Chinese foreign direct investment could translate into a potent technological force capable of taking on competitors like General Electric, BMW, and Airbus. The uncertainty is more in the timing – a question of when, not if, China will crack the global marketplace in cars, rail equipment, aerospace production, or robotics. But the speed at which the Byton came to fruition shows the future will likely be realized in a matter of years – not decades. So those who choose to wait will likely play catch-up when these what-ifs become reality.

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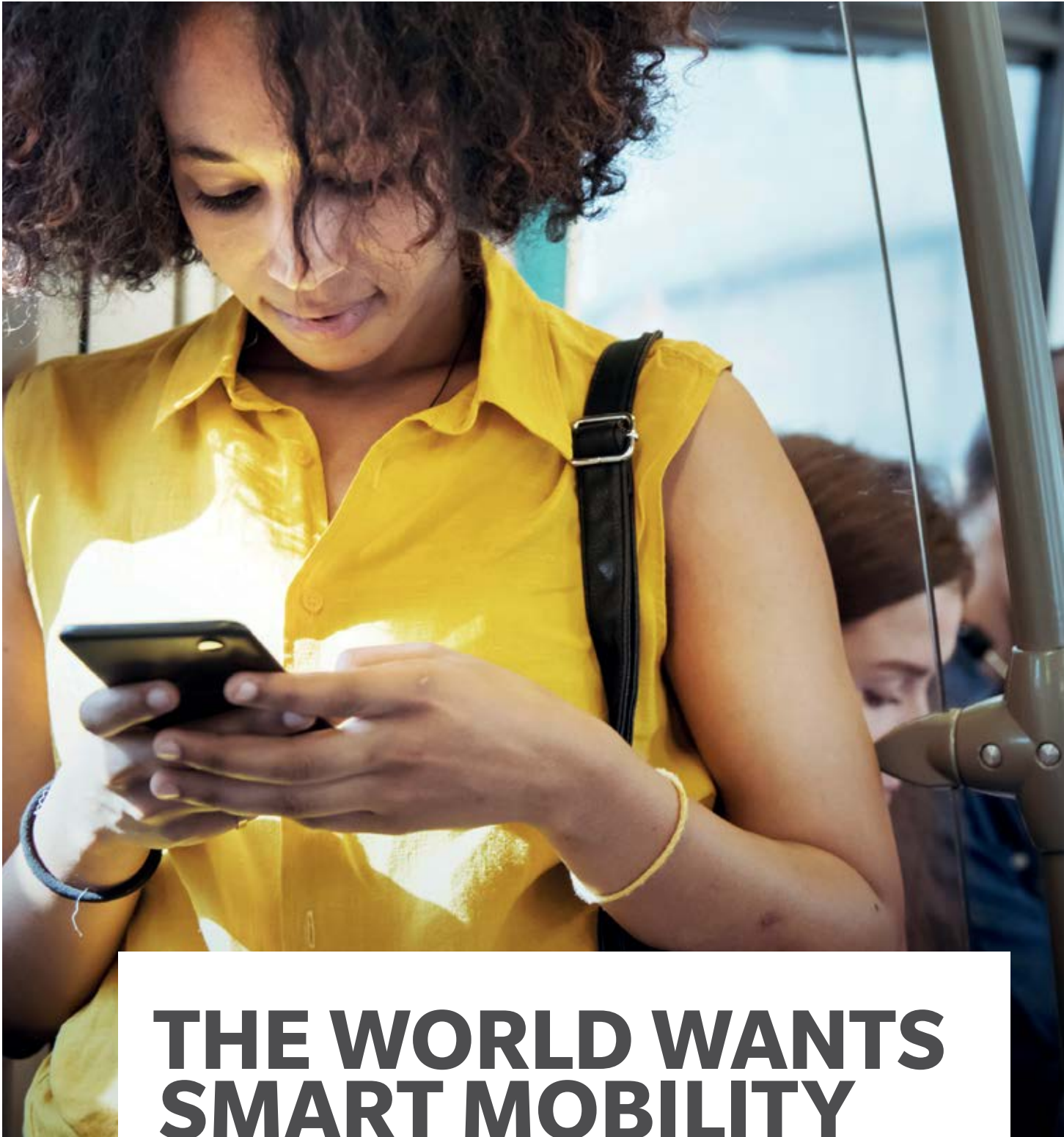
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The West needs to prepare now for the potential of a new, low-cost competitor – not after China launches products that match and surpass it





THE WORLD WANTS SMART MOBILITY

Survey says: Consumers would pay more and even switch modes of transportation to get seamless digital services

Joris D'Inca • Patrick Lortie • Anne Pruvot



ONBOARD EQUALS ONLINE. Travelers put a high priority on being digitally connected and on services that make trips easier and more productive.

THE FUTURE OF EFFICIENT, seamless, and personalized transportation gets closer to reality each year. Right now, it's seen in apps that order rides or book travel with a click or smartphone alerts that tell passengers how long until the next subway arrives. It's the apps that show drivers where to find parking spaces.

Not too many years from now, the same kind of centralized databases and platforms that make today's apps possible will give people access to driverless cars on demand and adjust the flow of city traffic, based on real-time data feeds. Commuters will be able to swap travel options on the fly, jumping from driverless ride-sharing to autonomous bus-train connections to avoid delay.

All this will be part of "smart mobility" – the future's digitally connected approach to today's travel problems. With smart mobility, digital platforms will be designed to manage the travel experience from end to end and allow consumers to plan, book, and pay for their trips through one outlet – even if several providers are required to complete the journey. Only a few clicks away, integrated travel services like route maps, real-time travel information, real-time seating choices, and advanced porter booking will be available.

The rewards of being smart

Right now, businesses are rushing to develop smart-mobility platforms and services, including travel operators like airlines and rail companies, digital giants such as Google and Amazon, and savvy technology startups. The rewards of unlocking smart mobility could be vast: Innovative mobility services are projected to see a fivefold increase in their share of travel spending by 2040 and generate an estimated \$270 billion in revenue and up to \$150 billion in profit for providers.

But are consumers ready to embrace smart mobility? Oliver Wyman conducted a survey of 7,500 consumers across Germany, France, Italy, China, and the United States, and it turns out the majority are ready to change their preferred mode of transportation and pay more to get access to these kinds of services.

The percentages of consumers who consider smart mobility important are overwhelming: In China, a stunning 98 percent of those surveyed ranked it as important or very important; in Europe, 93 percent; and in the United States, 83 percent. Among respondents 18 to 35 years old whose principal transportation is a private car, 97 percent said they would consider switching to public transportation to gain access to smart-mobility services. Even among those 65 and older, 76 percent said they would consider a change. For those who use public transportation, similar percentages would move to automobiles for smart-mobility advantages.

Consumers ready to spend more

The survey also found that 84 percent of respondents said they would shell out an additional fee to use integrated smart-mobility solutions. That includes 89 percent of millennials and Generation Z travelers and 75 percent of senior travelers.

Among commuters, many said they were willing to add a flat fee on top of their current transit bill each month for a bundle of smart-mobility services, similar to the way they opt to add premium channels to monthly cable charges. On average, commuters said they would pay 4.1 percent above their monthly commuting cost for multimodal, door-to-door journey planning and 2.9 percent more for real-time travel information and rerouting to avoid delays.

People also are willing to pay more for long-distance travel that involves smart-mobility services. Long distance, in this case, is defined as a trip of more than 100 kilometers. With these trips, consumers indicated they would pay on average 3.3 percent more, and as much as 5.8 percent more, for multimodal, door-to-door journey planning, and 2.4 percent more on average for real-time information and rerouting.

home but quickly switch to a subway if real-time data shows traffic delays. Another example would be the smart sensors and analytical tools that can help a city ease traffic congestion.

Beyond travel services, smart mobility includes activities that can keep passengers occupied during a trip – browsing shopping sites, taking online courses, and enjoying movies or music, for example – as well as those that offer options for the end of the trip, such as sightseeing or dining. It also can tie in related services, such as purchasing theft, casualty, and travel insurance. Like travel services, these would be provided via a digital platform that completes transactions with a click or two.

Here again, survey respondents showed considerable interest in improved access, with the addition of insurance services being the most popular. On average, respondents said that for long-distance trips, they would spend 5.4 percent more for the opportunity to buy travel, theft, and casualty coverage as part of the end-to-end journey and 2.5 percent more to access e-commerce sites. Daily commuters said they would pay an additional five percent for entertainment and 5.6 percent for educational offerings.

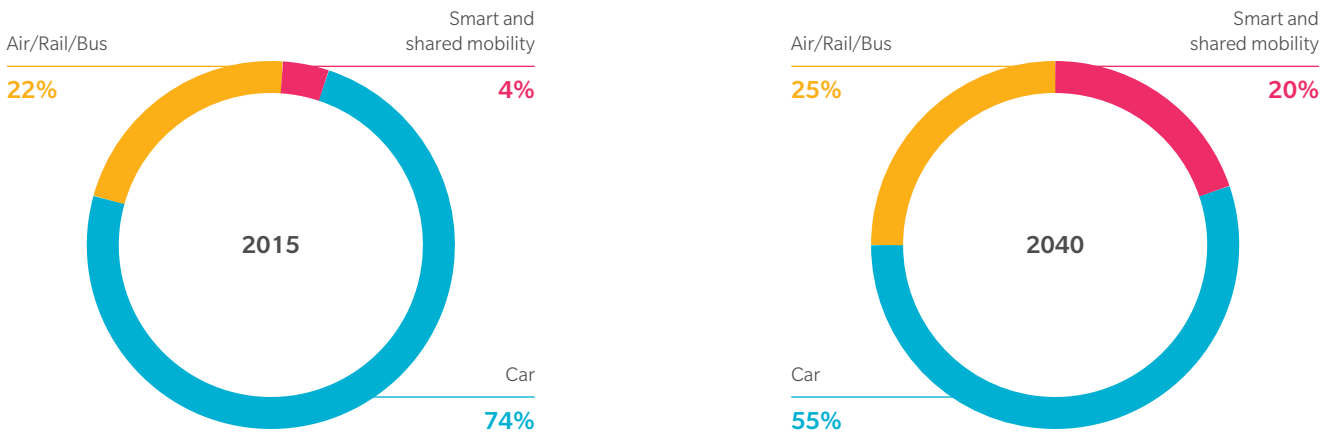
Seamless connections

An example of a personalized, flexible, end-to-end travel service consumers say they want is the digitally connected multimodal hub that allows passengers to seamlessly transfer from one mode of transport to another. This could be created at a train station or airport where, using an app, a traveler can arrange a ride-share

Getting there first

As autonomous and artificial intelligence technologies are increasingly incorporated into the daily lives of travelers, the race is on among travel operators, digital giants, and innovative startups to establish the first foothold and gain the advantage in smart mobility. The challenge will be to see which will develop more

SHARE OF PASSENGER TRANSPORT SPEND WILL INCREASE FOR INNOVATIVE SERVICES
RELATIVE CHANGE OF TOTAL MARKET IN PERCENT FOR REPRESENTATIVE COUNTRIES



Note: Includes China, USA, Germany, France, and Italy. "Shared mobility" refers to the sharing of previously individual mobility options, such as cars. "Smart mobility" refers to services that provide real-time, seamless travel data and options.

Source: Oliver Wyman analysis

dynamic, personalized offerings and seize a competitive edge by controlling smart-mobility portals that seamlessly connect transportation options.

No doubt, access to personal data and the ability to analyze it are necessary elements for building customized smart-mobility options. Despite recent breaches and tighter regulation on data, consumers still show a willingness to share personal information for a quid pro quo: More than half of the consumers surveyed in the five countries – and 80 percent in China alone – said they would give providers their personal data and travel preferences in return for services.

Currently, travel providers hold a slight edge with consumers, according to our survey. But smart mobility is a fast-moving target, with some data-savvy digital giants already entering parts of the market and successfully dominating many of the services not exclusively linked to travel. To stay ahead, travel operators may opt to partner with digital giants and startups to access the data and technical expertise needed to power the next round of travel innovation. Meanwhile, agile smart-mobility startups attracted \$40 billion in investments from 2011 to 2016, with the funding roughly doubling year over year.

To be sure, not even smart mobility will eliminate urban congestion and all travel delays. But a transformation in travel is inevitable. The challenge for

travelers and travel providers alike will be keeping up with the ever-shifting landscape of transportation and technology options reshaping long distance and local travel.

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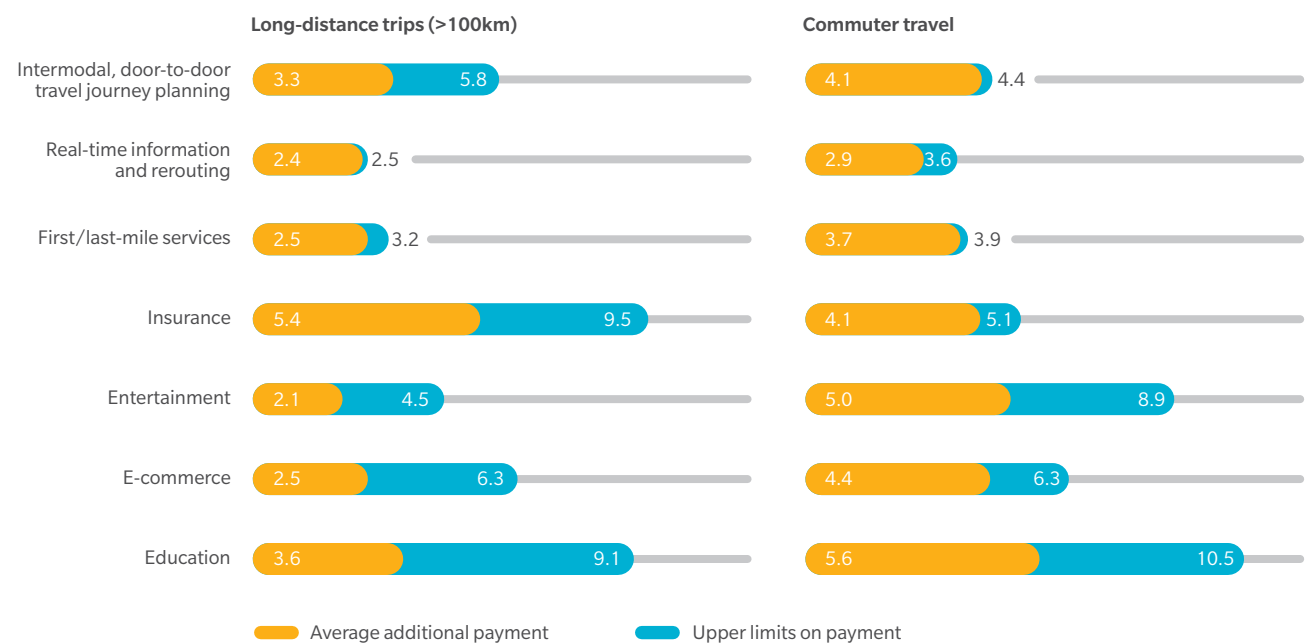
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For more information on this research, please see “Mobility 2040: The Quest for Smart Mobility” on www.oliverwyman.com. This article originally appeared in *Forbes* on August 28, 2018.

CONSUMERS ARE WILLING TO PAY EXTRA FOR SERVICES

PERCENTAGE ABOVE BASIC TICKET PRICE FOR LONG DISTANCE TRAVEL AND MONTHLY COMMUTING



Source: Oliver Wyman Mobility 2040: Smart Mobility survey

THE LAST MILE TO AUTONOMY

Driverless vehicles arriving ahead of schedule appear to offer bigger opportunities than first imagined

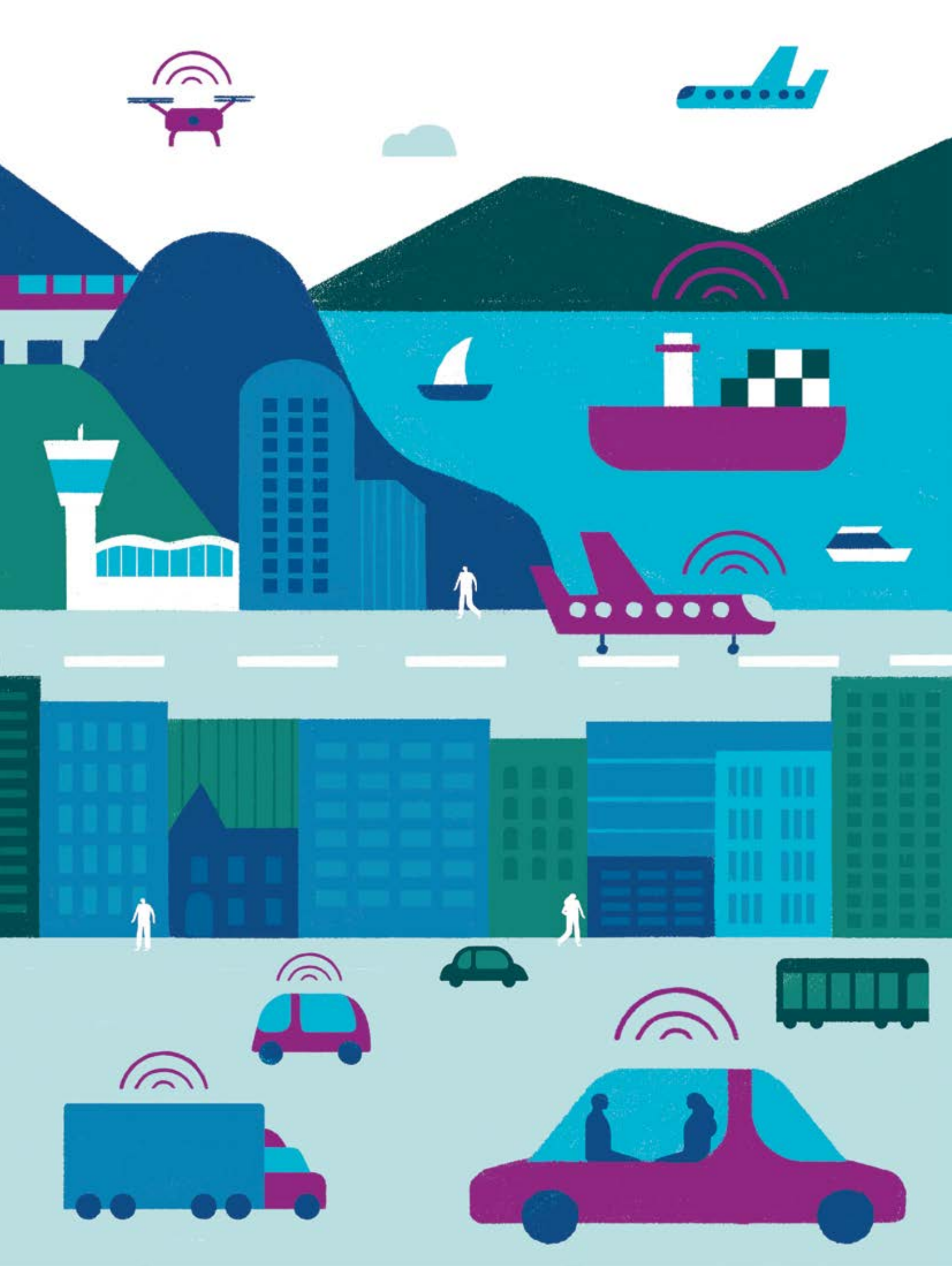
Guillaume Thibault • Hanna Moukanas

IN TRANSPORTATION, there is probably no word more widely used and simultaneously more of a mystery than autonomy. Although autonomy's exact implications for mobility are hard to fully grasp today, the industry recognizes the technology offers so much more than the novelty of the self-driving, flying taxis being tested in Dubai or even an immediate game-changer like the driverless trucks that haul Frigidaire refrigerators along the Interstate 10 between Texas and California.

Consider autonomous vehicles alone. While today the market for autonomous vehicles consists primarily of unmanned military drones, our research shows that over the next 12 years it will transform into one that is 60 percent civilian; include ground, sea, air, and space transportation; and expand to €636 billion (about \$739 billion) – more than 40 times its current size. According to our calculations, autonomous vehicles will make up 20 percent of the total vehicle market by 2030, and three out of four of them will be used as ground transportation.

For the entire transportation and services sector – including public infrastructure; mobility





services; traffic, fleet and data management; defense and security; and maintenance, repair, and overhaul – the arrival of autonomy means a fivefold increase in the market to almost \$3 trillion. While the entire sector faces seismic shifts with the incumbent disruption, its players and myriad startups can expect outsized opportunities.

The next internet-size disruption

Like the commercial effort to capitalize on the internet that began two decades ago, autonomy is changing the way we live – how we move from place to place, what we choose to own, and eventually the leaders in the transportation industry. With autonomy advancing more rapidly than initially predicted and now expected to reach a tipping point in 10 years rather than 20, General Motors Chief Executive Mary Barra got it right when she reckoned transportation would see more change over the next decade than in the last six.

In this transition, the value is moving from large, sophisticated, and expensive platforms to small, agile, and low-cost ones. For instance, 30 percent of the helicopter market will be threatened by small to midsize drones, such as the ones being developed by DJI, Delair Tech, and Parrot.

Rather than a plethora of new hardware, the emphasis will be on development of software, which will make up half of the systems on vehicles versus 30 percent today. Here, names like QNX, Nvidia, Intel, Google, Airware, and Kespry stand out. And

finally, by 2030 shared ownership – a trend that will be further encouraged with the arrival of autonomous vehicles – will be five times higher than today. To respond to the move away from ownership, major car manufacturers have been partnering with on-demand ride services like Lyft and Gett.

Beyond autonomous vehicles

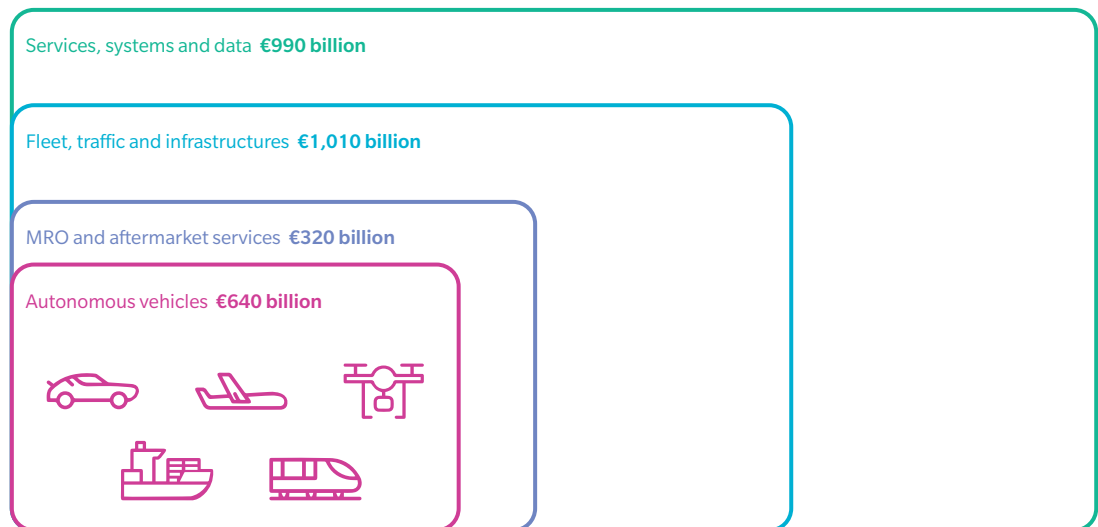
But vehicles are only a small piece of the transformation spawned by autonomy. In the services sector, there will be similar disruptions. Take traffic management. Today, there are 300,000 aircraft in the general aviation fleet and five million drones sold annually. Given that traditional traffic management tools don't detect small unmanned vehicles, the size of the potential challenge is clear.

While discussions so far have focused on creating dedicated roadways or corridors for autonomous vehicles, NASA and Google have also been working to develop traffic management systems that would allow for the coexistence of manned and driverless vehicles. And besides traffic, there will be an array of other infrastructure overhauls required to accommodate autonomy – from parking, to servicing, to airports, to mass transit systems.

So who will be among the winners? We've already seen some companies that have positioned themselves astutely for the coming wave of autonomy. For instance, given that electric cars lend themselves to autonomous operation, Tesla – with its electric cars, emphasis on

AUTONOMY WILL GROW TO ALMOST €3 TRILLION BY 2030

VEHICLES ARE ONLY A PORTION OF THE MARKET



Source: Oliver Wyman analysis

software and data collection, and remote upgrades and repair – has an advantage moving forward over car manufacturers that haven't strayed from internal-combustion engines.

Challenges ahead

But even as more autonomous prototypes make their way toward commercialization, obstacles still exist. We're already seeing progress in battery technology, but more is needed. Still, the biggest roadblocks may be regulation and ultimately how comfortable the public is with cars driving themselves or pilotless aircraft. There was one survey that said only 17 percent of people would fly in a plane without pilots.

Gaining the certification to ensure the safety of the vehicles, as well as securing public infrastructure investment from debt-encumbered governments, will also be high hurdles. No doubt, there also will be pushback from labor in jeopardy of being replaced as well as from some incumbents uncomfortable with the pace of adoption.

Ultimately, autonomy and artificial intelligence are forces too big and too game-changing to be stopped.

And we are already seeing companies capitalize on the opportunities. As Charles Darwin once said about another immutable force, "it is not the strongest species that survive, nor the most intelligent, but the most responsive to change." Autonomy may not give business the choice of not changing.

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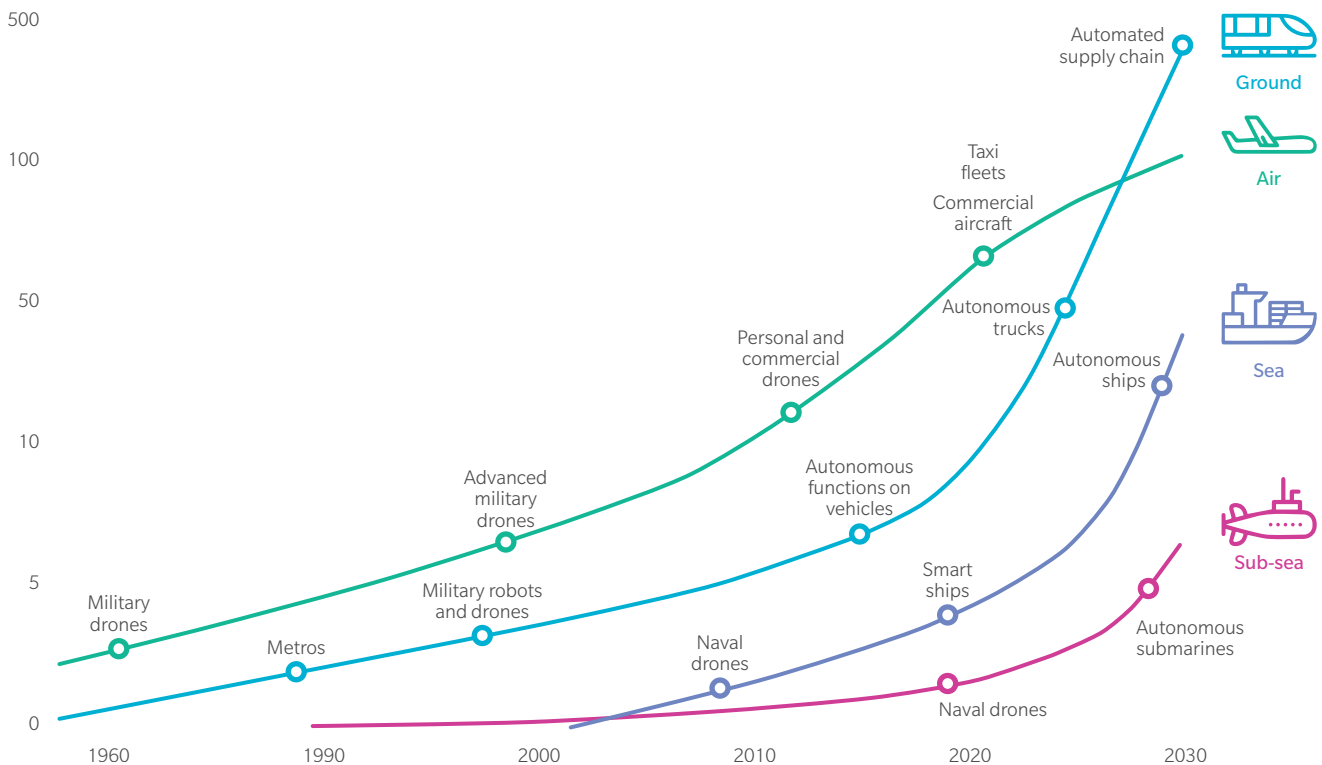
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This article first appeared in Forbes on February 5, 2018.

WITH EACH NEW GENERATION, THE AUTONOMOUS VEHICLE MARKET SIZE GREW ALGORITHMIC SCALE IN BILLIONS OF DOLLARS



Source: Oliver Wyman analysis

AUTONOMOUS TRAFFIC JAM

The newest technology may not save trucks from highway congestion, potentially benefiting rail over the short haul

Patrick Lortie • Rod Case • Alexandre Lefort

THE TRADITIONAL COMPETITION between freight railroads and trucks in North America is about to escalate as new economic and technological forces come into play over the next several decades. The development of connected and autonomous vehicles (CAVs) could substantially reduce truck operating costs, making trucks more competitive with rail just as the economy is shifting toward more truck-favorable goods.

Trucking companies are already testing new technologies through “platooning” – in which two or three wirelessly connected vehicles with advanced driver assistance systems travel together. This allows for much closer spacing between trucks, reducing fuel costs. The next step will be multiple driverless trucks that follow a lead truck with a driver. Together with other technology improvements, overall truck operating costs could drop 40 percent in the next 10 to 15 years.

New Oliver Wyman research suggests, however, that there is one problem for trucking that technology won’t solve for at least the next two decades at least: Highway congestion is going to continue to increase – particularly in and around large urban areas. This will have an outsized impact on trucking, possibly leading to service deterioration and supply chain disruption. It will also create an opportunity for rail.

The capacity conundrum

Vehicle traffic, including truck volumes, are projected to rise steadily through 2045, as more Americans establish homes in cities and suburbs and e-commerce increases freight volumes. This

THE CURSE OF CONGESTION: Because finding drivers is no longer a problem, autonomous trucks may end up cruising highways 24/7, which means more traffic and wear-and-tear.





means that as the number of cars and trucks grows, roads are going to get a lot more crowded in the near term.

What impact will autonomous vehicles have on all of this? Thanks to tighter spacing, more stable speeds, and safer vehicles, commercial truck platoons should make more room on the roads for cars and smaller trucks. As cars also get smarter, even more highway capacity will be created.

That said, this won't matter if smart cars and trucks end up being on the road a lot more. Will people abandon public transit and carpooling for longer single-person commutes? Will "fleet" autonomous vehicles endlessly travel the roads between pickups? Will automated trucks take up highway capacity 24/7, essentially creating a "rubber-tire railroad"? As of now, it's simply too early in the game to answer these questions with certainty.

Future shock

Still, it is possible to consider potential scenarios for the impact of CAVs as a guide toward competitive and public policy decision-making. To this end, Oliver Wyman recently developed a range of scenarios for key highways in several states and

metro areas through 2045. These scenarios consider various assumptions about traffic growth and the timing and penetration of autonomous cars and truck platoons.

As shown in the accompanying maps, our most likely scenario found that significant peak hour congestion will spread out from the central cores of big cities like Los Angeles and Atlanta to encompass much larger areas. While highways outside of metro areas will be less affected, popular connectors, such as State Highway 114 between Dallas and Fort Worth, will see much higher peak-hour congestion.

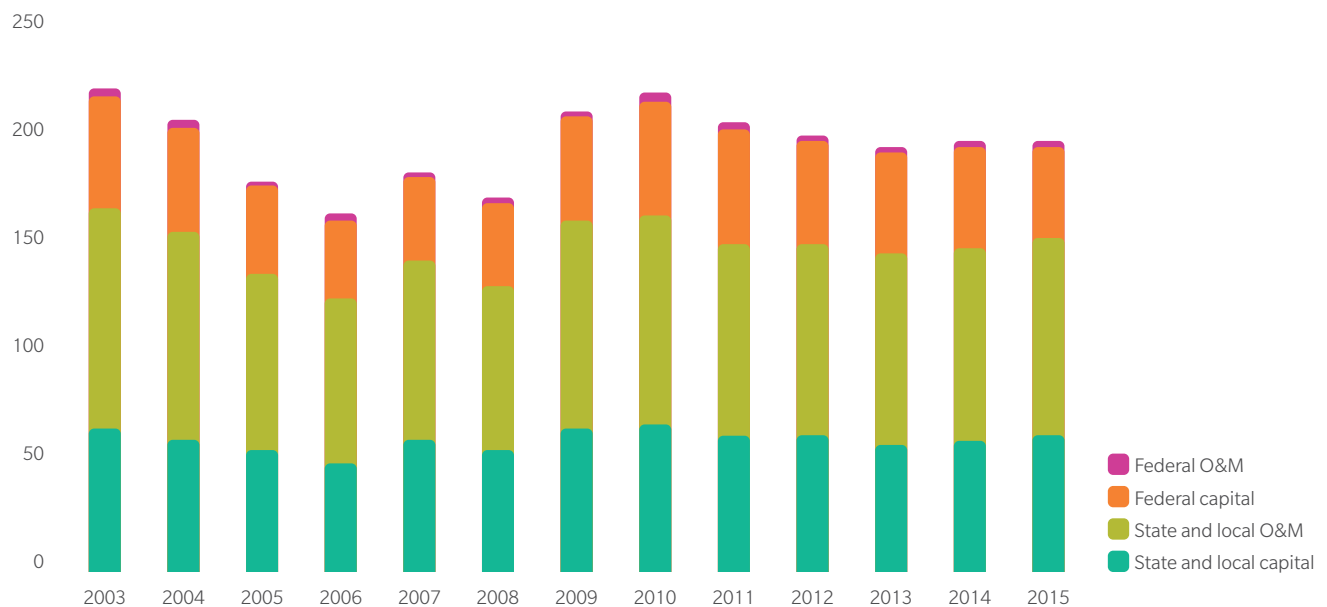
For the sampled states, Oliver Wyman estimates that truck vehicle-miles traveled on roads already above capacity will rise from 4.7 million in 2016 to 52.2 million in 2045 – an eleven-fold increase.

The need to tax

More cars and trucks mean more wear-and-tear to on the nation's highways and roads. Meanwhile, federal and state governments have been unable to keep pace with highway infrastructure investment needs. Federal and state per-gallon fuel taxes – which pay for highway maintenance and upgrades – have barely increased. The federal fuel tax hasn't risen since 1993; state

MORE POTHOLES ARE LEADING TO MORE CONGESTION

GIVEN THE INCREASE IN TRAFFIC, GOVERNMENT ISN'T SPENDING ENOUGH ON ROAD REPAIR (2015, IN BILLIONS OF US DOLLARS)



Sources: Federal Highway Administration, Highway Statistics, various years, tables HF-10, HF-10A, FA-5, SF-2, and LGF-2; Federal Highway Administration, National Highway Construction Cost Index (NHCCI) 2.0; and Oliver Wyman analysis

fuel taxes have gone up, but not enough to make up the shortfall.

Commercial trucks benefit from the failure of government to raise taxes: The industry already pays less in fuel taxes than the cost of the damage that its trucks do to highways. By contrast, US freight railroads privately fund nearly all their infrastructure.

With an ever-widening gap between fuel taxes and investment infrastructure needs, lawmakers are forced to consider funding alternatives, such as direct highway user fees. Tolling is one option: From 2005 to 2015, state toll road mileage increased 18 percent for interstate roads and 23 percent for non-interstate roads.

A second option would be a tax on vehicle-miles traveled, which a few states are researching. While the tax is likely to ease the current investment shortfall in highway infrastructure, getting it passed would be a heavy lift politically.

Rail's opportunity

As more and more trucks compete for space on congested roads, rail could prove to be an attractive alternative for some shippers, especially for containerized freight. Oliver Wyman estimates that if congestion results in a diversion of 20 percent from truck to rail of the 43 million annual non-bulk truckloads that travel at least 500 miles, this would equate to an additional 8.5 million rail intermodal shipments per year, a 33 percent increase over current projections.

Rail has a couple of advantages, compared to trucks facing highly congested road conditions: Trains can move through many intermediate urban areas faster than trucks, and many rail intermodal terminals are in urban areas. That means shorter truck hauls from terminals to customers, the final leg of the trip. Railroads could further capitalize on this situation by opening more terminals in areas where increased congestion is likely. Where they have enough space next to the rail line, railroads could even create truck-only roads to speed up deliveries to customers.

There are two caveats, however, for rail. Once the penetration of self-driving passenger cars becomes high and the number of non-CAV cars on the road falls, the freed-up highway capacity will stop the growth of congestion, most experts believe. Under such conditions, rail could see a decline in intermodal volumes or have to reduce prices to prevent that.

Second, even if railroads are able to divert intermodal truck traffic for a time, their overall market share of transportation will still drop over the next 25 years; the only question is by how much. That's because the overall economy is accelerating away from the traditional low-value, bulk goods that favor rail, such as coal. The fastest-growing commodities will be lightweight,

The trucking industry already pays less in fuel taxes than the cost of the damage caused by trucks to highways

high-value electronics and consumer goods. Shipment sizes and distances will continue to shrink as well, as customized items drop ship on demand directly from manufacturers and artificial intelligence-based predictive inventory practices move goods automatically from local distribution centers to customers.

If the rail industry is to continue growing and thrive into the mid-century, the longer-term outlook indicates a need for rail to evolve in tandem with the changing economic and transportation landscape. These changes need to be groundbreaking, involving adaptation on multiple fronts, from a more aggressive focus on resilience and better use of the rail network to productivity improvements and long overdue technology innovation.

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BUMPER TO BUMPER

Traffic in urban America will only get worse as autonomous vehicles hit the road, cutting operating costs for trucking

TRAFFIC CONGESTION WILL become progressively worse by 2045, with 20 to 60 percent of National Highway System roadways in urban areas experiencing above-average levels during rush hours, according to Oliver Wyman research.

Pictured here are the most likely scenarios for congestion during peak travel hours on interstates, freeways, and other key connectors in and around Los Angeles, Atlanta, and Dallas. The analysis is based on forecasts for truck and automobile traffic growth as well as the pace and penetration of autonomous vehicles. The introduction of autonomous trucks, for example, is expected to lower freight costs, which will probably increase the number of trucks on the road over time.

As thoroughfares approach capacity, disruptions – such as accidents, breakdowns, or the loss of lanes because of construction – are more likely to reduce travel speeds and even bring traffic to a halt at times. The yellow, orange, and red portions of the maps indicate areas of increasing congestion, where drivers can expect to move well below speed limits during peak travel times. Red indicates the heaviest stop-and-go traffic.

For all three cities, congestion is expected to expand outward from central metro areas, eventually encompassing even the alternate routes that drivers now use to avoid traffic jams. In response, drivers are likely to stagger their travel times, increasing the number of hours each day that major roads experience congestion. Lack of investment in highway infrastructure also is expected to further exacerbate traffic problems.

LOS ANGELES

2016



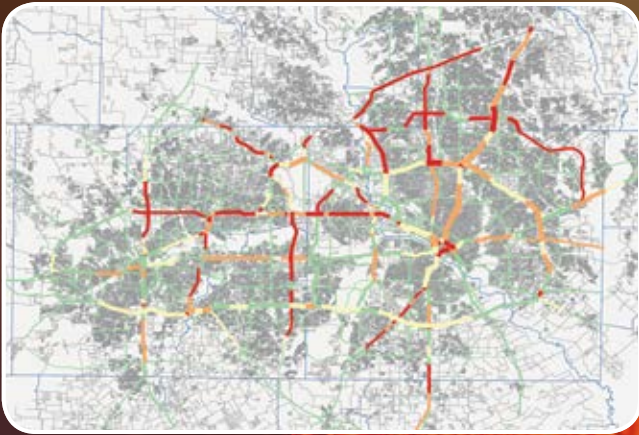
2045



Source: US Department of Transportation Highway Performance Modeling Systems, Department of Transportation, Oliver Wyman analysis

DALLAS

2016

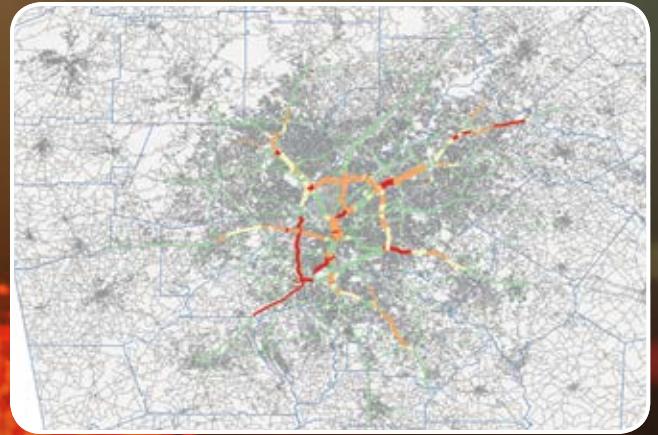


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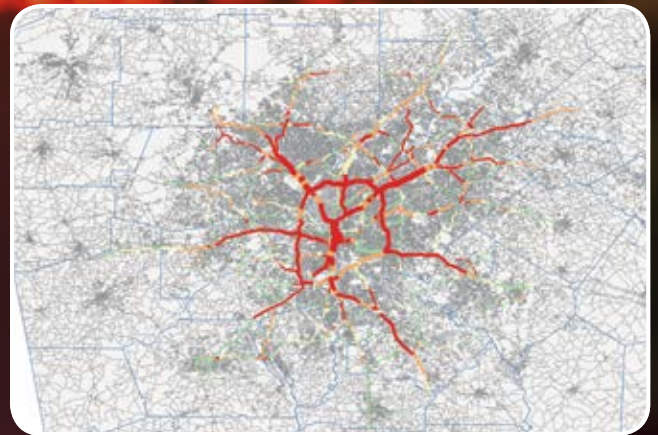


ATLANTA

2016



2045



OPEN TO CYBERATTACK?

How global, interconnected supply chains may become vulnerabilities for aviation and aerospace

Brian Prentice • Paul Mee





IN MARCH, THE US DEPARTMENT of Homeland Security and the Federal Bureau of Investigation issued a troubling alert: Since the same month two years before, Russian state-sponsored hackers had been infiltrating the nation's electricity grid and various infrastructure industries, including aviation, collecting information on how the networks were organized and what systems' controls they had in place. While no sabotage appears to have been perpetrated, the unsettling question remains – what are the Russians going to do with the data they collected?

While all these industries, especially their biggest players, tend to have extensive cybersecurity in place, it may not be as comprehensive as the nation would hope. In this case, instead of gaining access through the front door, where the alarm system was more robust, these hackers simply went around back and entered through the more vulnerable networks of third-party and supplier

IN PLAIN SIGHT: Some of the worst cyberattacks have been carried out by an employee of a trusted third-party vendor.

operations, relying on myriad techniques including phishing emails infected with malware and the theft of credentials.

Needless to say, the scenario should send chills throughout the aviation and aerospace industries. While major aircraft manufacturers and airlines make obvious targets because of the potential to conspicuously disrupt international commerce, they also rank high on hackers’ to-do lists because they maintain global, highly interconnected supply chains that over the past few years have been aggressively digitizing operations. More digitization means more attack surface for hackers. The many links on aviation’s and aerospace’s supply chains – some big, many small to midsize – all become potential vulnerabilities, given the daunting task of ensuring that vendors with access are capable of providing the same level of rigor in both their cybersecurity and their employee training.

Vulnerable links

While the biggest organizations within the industry’s fold may have advanced cybersecurity, the same cannot always be said about the vast network of service providers and suppliers. Many of these are considered members of the maintenance, repair, and overhaul (MRO) industry that services the nation’s aircraft.

In a 2018 Oliver Wyman survey of the MRO industry, responses revealed potential holes in the bulwark. For instance, while 67 percent of respondents said their company was prepared for a cyberattack, fewer than half were able to say whether they had conducted a cybersecurity review in 2017. Only nine percent of independent MRO providers, 50 percent of airframe, engine, and component manufacturers, and 41 percent

of airlines confirmed that they have established security standards for third-party vendors. That leaves potentially many companies without a clear view into the digital security of vendors – almost all of which maintain credentials to log onto their systems.

And that lack of knowledge can lead to disaster, as many major corporations have discovered over the past five years. In 2013, for instance, hackers used the stolen credentials of a heating, ventilation, and air conditioning vendor to penetrate the network of retail giant Target to steal the data of 70 million customers and information on 40 million payment cards. The cost to Target: close to \$300 million.

While cyber criminals in earlier decades seemed motivated by the money that could be made off stolen data, recent breaches seem more intent on creating organizational chaos. In June 2017, hackers – believed by the CIA and UK intelligence to be Russian military – attacked Ukraine with software that literally wiped out data and disrupted operations in that country’s banking system, government ministries, and metro, and at the former Chernobyl nuclear power plant.

A global emergency

From there, the wiper ransomware, named NotPetya, infected computer systems around the world, including those of Danish shipping conglomerate Maersk. This led to serious delays at major ports like Rotterdam, Mumbai, and the Port of New York and New Jersey, and the temporary shutdown of the largest terminal at the port of Los Angeles. It is attacks like this one that should prompt transportation companies to reassess their level of cyber preparedness.

Globally, hacking has become a growth industry, costing economies around the world more than half

HOW PREPARED IS THE INDUSTRY?



Source: MRO Survey 2018; Oliver Wyman analysis

a trillion US dollars annually – a sum that has been increasing every year. In some countries, hackers work out of regular offices and get paychecks to spend their workday looking for vulnerabilities in organizations’ digital networks, lying in wait for holes to develop through which they can penetrate and steal information or worse. Experts place the number of professional hackers at over 300,000 worldwide. In places like Russia, China, Eastern Europe, and North Korea, hacking is on the rise.

To achieve a comprehensive, unified cybersecurity and risk management strategy for the industry, MRO providers should seriously consider taking several actions. First, companies within the industry should conduct independent audits of existing cybersecurity programs. This includes looking at everything from understanding who and what have access to a company’s computer network, to whether a real-time detection process and a response system have been delineated, to which managers are responsible for each phase of the cybersecurity protocol, to whether oversight exists to ensure procedures are followed and documented.

practices intended to be leveraged in designing such a cybersecurity framework.

Finally, the industry must work across companies to fortify their information technology systems – both infrastructure and upkeep – and create a security-minded culture. While no solution is guaranteed to avert any and all attacks, developing a holistic approach to the risk management of cybersecurity that’s shared across the industry – and updating it regularly – may give companies a leg up. Certainly, cyber criminals aren’t standing still.

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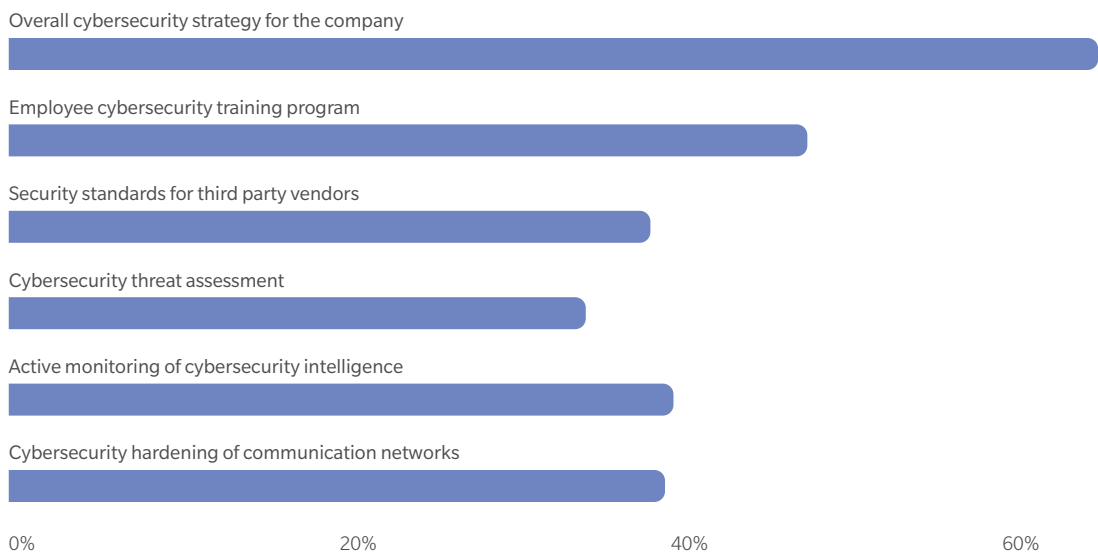
This article originally appeared in Forbes on April 11, 2018.

Industry standard

The industry as a whole also needs to develop a clear framework for mitigating and managing cyber risks. The National Institute of Standards and Technology has developed a set of industry-specific standards and best

WHICH CYBERSECURITY SAFEGUARDS HAS YOUR COMPANY IMPLEMENTED?

PERCENT OF TOTAL RESPONDENTS WHO SELECTED EACH RESPONSE FOR EACH SEGMENT



Source: MRO Survey 2018; Oliver Wyman analysis

THE PART YOU DON'T SEE: Cars were once all about the hardware, but designing a car in the future will be more about the data it produces.



RE-ENGINEERING ENGINEERING

How data and digitization can revolutionize product design and development

Kevin Smeets • Marc Boilard • Simon Schnurrer



TODAY, THE NUMBERS OF SENSORS and digital systems collecting data on aircraft, railway cars, locomotives, and automobiles are rapidly expanding, changing the transportation experience for passengers as well as for those at the controls. Technologies like artificial intelligence and machine learning are transforming the basics of how transportation equipment operates. And customers, recognizing the possibilities, are demanding ever more customized equipment and intelligent interfaces reflecting the most current capabilities.

But the new components and technologies are also reshaping the way engineers design and develop this

equipment. They create opportunities that, when used to full potential, can contain research and development (R&D) costs and substantially speed up the incorporation of innovations – allowing manufacturers to better adapt to rapidly changing customer demands.

In the past, inventing transportation equipment required a trial-and-error process and multiple prototypes. For instance, developing a new model of car typically took close to four years, with the model staying on the market for seven years. For aircraft and rail rolling stock, the combined timetable for development and the equipment's time in service can be three to four times longer than for autos. Given the current pace of technological change and adoption, that's too long.

Real-time innovation

Digitization is changing the playing field for engineers. It alters the culture by providing more real-time data on the performance of equipment in the field today, allowing engineers to consider improvements that can be achieved in months through data algorithms rather than years or decades. Instead of focusing only on breakthrough technologies and new models, engineers can significantly expand the capabilities of equipment already in service through incremental upgrades in software.

Transportation manufacturers can operate more like an Apple or Microsoft, sending software updates to improve performance or security. Regular upgrades and the flexibility that digital systems provide are revolutionizing what original equipment manufacturers can offer customers – and what engineers can develop. Take, for instance, Tesla with its electric vehicles and their substantial digital content. Since its inception, the electric car company has let customers incorporate technology upgrades through simple downloads while vehicles sit in the garage or are parked on a street.

The pressure to keep technology cutting edge is even more intense for aircraft and rail equipment manufacturers whose products remain in service for decades. Public transport authorities are beginning to demand faster turnaround on new trains and trams to provide riders the latest comforts and conveniences; airlines want to distinguish themselves in the market with more customization of their planes and the customer experience through advanced connectivity.

The realities of budgets

Making sure that products keep up with technological advances costs money at a time when most manufacturers are forced to look for cuts. As a result, engineering departments are transferring funds from

traditional R&D to digital in an impossible race to reduce both the cost and time to reach market with new products.

Annually, equipment makers budget more than \$814 billion (€700 billion) on R&D and engineering – a significant cost of operation. Adopting data-driven engineering could shave up to 10 percent off these budgets, with the savings likely to increase as transportation equipment becomes more digital, autonomous, and electric.

To accomplish this, engineering departments will have to change how they work. Here, we explore six trends that are redefining the design and development of transport equipment.

TREND 1: TWO TYPES OF ENGINEERS

The biggest challenge facing transportation companies is finding candidates with the right mix of engineering skills. The growing technical sophistication of transportation equipment demands deep expertise in narrow scientific fields like artificial intelligence, but their complexity also creates a need for system engineers and architects. These specialists, probably the hardest of engineers to find, have mastered several engineering disciplines and can address a product holistically, understanding how various systems interact and support each other.

Meanwhile, as human resources departments look to recruit more engineers, information technology tools and artificial intelligence systems will be taking over certain engineering assignments, primarily simple design tasks. It's estimated that robots will eventually take over as much as 25 percent of the work of engineers, just as they have replaced production workers in factories and changed the skillset necessary for those remaining.

TREND 2: OPEN ENGINEERING ECOSYSTEMS

Whereas outsourcing was once a means of cutting costs, today it's done to access new skills in areas like artificial intelligence or reassign legacy work so in-house engineers can focus on new technologies. That often involves collaborating with technology startups, which can create culture clashes. The tech industry is accustomed to perfecting systems over time based on usage data, but for transport equipment makers, problems in the field can threaten more than their reputations and customer relationships. Yet, the two types of engineers need to work together, which will require more alignment between engineering processes, signoff procedures, and validation requirements, among other things.

Already, major companies leverage ecosystems – essentially teams of in-house and

AT ALL STAGES OF LIFE, DATA PRODUCED BY AIRCRAFT ARE OPTIMIZING PERFORMANCE
BEING ABLE TO RETROFIT PLANES WITH SENSORS IS PROLONGING THEIR TIME IN SERVICE



JUST OFF ASSEMBLY LINE

Real-time data during entry-into-service improves early troubleshooting

- Manufacturers get real-time performance data from aircraft instead of reports from airlines
- Software upgrades, based on performance data rather than just maintenance, address problems

Aircraft can optimize performance with real-time updates

- New sensors measure everything from fuel burn to vibration modes and resistance to movement
- Engines, environmental systems, and flight controls adapt to optimize performance in real time



ACTIVE SERVICE

Real-time data on traffic and weather optimizes fuel burn and flight time

- Data from satellites and weather sensors inform aircraft
- Aircraft automatically calculates the best routes and altitudes

Predictive maintenance is powered by machine learning

- Hundreds of real-time data points inform maintenance schedule
- Early warning signs provide alerts on potential maintenance issues
- Aircraft notifies the airline about which parts it needs before landing

Sensors provide airline with data on the in-flight passenger experience

- Data comes from seat and bin sensors and in-flight entertainment
- Environmental sensors adjust aircraft temperature and humidity



DELAYED RETIREMENT

Airlines can retrofit aircraft with sensors and hardware

- New technology extends aircraft life by pinpointing maintenance and reliability issues
- Airlines get support from targeted upgrades to address plane aerodynamics and corrosion

Manufacturers collect data to improve the design of the next generation of aircraft

- Full lifecycle data shows how an aircraft will perform as it ages, helping to extend the life
- Passenger use and experience data helps refine product development

Source: Oliver Wyman analysis

outsourced engineers from multiple companies working together – in half of their programs, according to an Oliver Wyman survey. But many transportation companies said in survey interviews that they had problems finding the right ecosystem for software development. Among the biggest hurdles for most organizations are maintaining control over design methodologies, the lack of standardized IT systems, and mitigation of the potential for cyberattack when working with third-party vendors.

TREND 3: OPTIMIZE DESIGN WITH PRODUCT DATA

New engineering initiatives are arising from the growing pools of data supplied by aircraft, automobiles, and railway cars themselves. Manufacturers have added more and more sensors to their products as the cost has come down and advanced analytics become available to interpret the data. Oliver Wyman believes equipment manufacturers could gain \$10 billion annually from improvements based on such Internet of Things data.

Even in aviation, where product data has been used for years, manufacturers are finding new implementations. For example, flight optimization equipment is being introduced that would allow flight plans to be altered based on real-time data on weather and traffic, leading to better fuel use and fewer delays. Planes are also sharing data more readily with air traffic control and other aircraft to improve safety and traffic management.

For automakers, the problem has been the fact that data rarely makes it back to the engineers. Vehicle internal error codes are tracked and used by repair shops to diagnose problems but often deleted after the car is fixed. If they were fed into a database, engineers could track frequently recurring problems with, for instance, navigation and infotainment systems, and find the root causes. They could then fix them in subsequent designs.

TREND 4: CUSTOMER-CENTRIC PRODUCT DESIGN

Demand for customization means that engineering companies are working closer than ever with their customers. Sixty percent of top performing companies now collaborate intensively with their customers to get feedback on products and understand what they want next.

Equipment makers do not involve their customers in the technical design, but smart ones use them as integral parts of the testing process for new technologies. In the past, train operators were invited to give feedback on new trains already in production, but now manufacturers provide virtual simulators to let drivers try out different designs before the production phase.

In automobiles, by monitoring drivers' habits digitally, automakers might identify driving patterns that cause higher emissions and adjust the exhaust systems' control algorithms for individual drivers.

TREND 5: PDM AND OTHER IT TOOLS

Project data management (PDM) tools are one way to cope with the growing complexity. PDM arranges a technology system into a connected library of subsystems, a bit like LEGO blocks, and allows data sharing across a company, removing functional silos. It can speed up development and cut the design cycle in half. PDM could be particularly useful for the rail industry, where there's more scope for customization than in automotive or aerospace, and where the need to limit complexity makes data about every variable easily accessible. Rail manufacturers have initiated the journey to modularization of sub-systems, and automakers are using similar parts on multiple platforms. Yet, engineers are often reluctant to adopt new IT tools like PDM, with their rigidity and poor user interfaces that are often a struggle to use. These are problems that software editors need to address if they want their technologies to be fully implemented.

TREND 6: FULLY AGILE DEVELOPMENT

Traditional engineering development was based on a steady sequence of steps from concept to implementation. Sometimes engineers wouldn't know a system wasn't working until far into the testing process, forcing them to lose time as they go back to re-engineer it. Today, software uses agile processes in which teams quickly iterate, test, and gather feedback on a product. Big tasks are divided into smaller ones, and teams tend to work in sprints.

As the digital content of engineered products grows, companies will increasingly turn to agile methods. The result is much faster product development cycles, with estimates that agile processes will deliver faster results in over 90 percent of projects. Even with this impressive number, it may not be easy to get engineers to give up their traditional development process.

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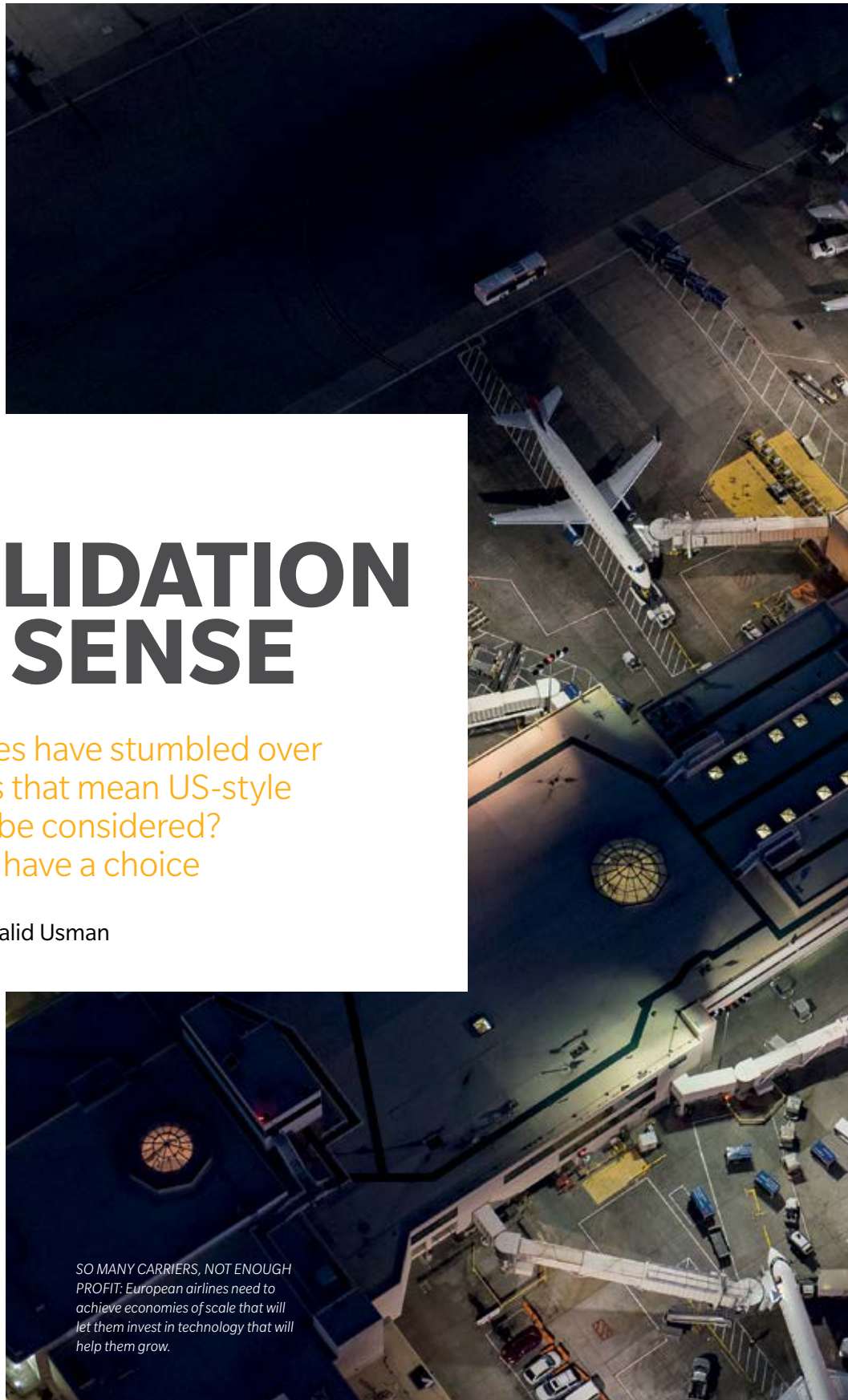
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For more on the Future of Engineering, please see our recent report entitled Engineering 2030 on www.oliverwyman.com.

WHEN CONSOLIDATION MAKES SENSE

A few European airlines have stumbled over the last year, but does that mean US-style consolidation should be considered? The industry may not have a choice

Bjoern Maul • Bruce Spear • Khalid Usman



SO MANY CARRIERS, NOT ENOUGH PROFIT: European airlines need to achieve economies of scale that will let them invest in technology that will help them grow.



A DECADE AGO when airlines based in the United States began to consolidate, the industry was in a terrible state. Between 2001 and 2010, American carriers lost \$55 billion and cut 160,000 jobs. A series of calamities – starting with the popping of the dot-com bubble and the 9/11 terrorist attacks, followed by a global recession that didn't end until 2009 – led to as many as 20 airlines filing for bankruptcy protection. As a result, the industry shrank from 10 major carriers to four.

The European airline industry today is nowhere near that kind of crisis. Despite the failure of three carriers in the past 18 months – Alitalia, Air Berlin, and Monarch – most remain profitable, although in some cases barely. Even so, the prospect of consolidation looms as a necessary, if not inevitable, next step for European aviation. The problem is not imminent collapse, but rather the inability for many European carriers to invest, innovate, and grow at a level that would allow them to keep up with international rivals – or even forge ahead.

Compared to North American airlines, the European aviation sector is more fragmented and less profitable, and shows insufficient capacity discipline. Carriers that have been attempting to consolidate the market are still unable to replicate the economies of scale that the biggest US airlines have achieved. Today, the top five intra-North American carriers command a 77 percent market share versus a 51 percent market share for the top five intra-European airlines. And that difference explains in large part why the American industry enjoys steady profitability and impressive capacity discipline, while Europe's doesn't.

Organic growth for European airlines also has become more challenging, with increasing capacity bottlenecks at key airports that contribute to an inability among carriers to expand routes and profitable passenger categories. Yet another constraint on growth, European airlines – like their North American counterparts – face shortages of pilots and mechanics to service a fleet that is gaining size annually.

Digitally challenged

More important, around the world, the industry is recognizing new potential through technology and digitalization. Advances in artificial intelligence and predictive analytics offer significant opportunities to improve the customer experience, reduce maintenance costs, and boost operational reliability and safety. Their adoption would allow airlines to offer the kind of hyperpersonal, customized environments that consumers are experiencing in retail, entertainment, and communications. But these solutions require

substantial investment – something that’s difficult for most European carriers, given their current finances.

Simply put, with the obvious exceptions of global group carriers such as Lufthansa, IAG, and Air France-KLM and profitable low-cost airlines like Ryanair, many European carriers lack the wherewithal to compete in the 21st-century technology landscape; even for bigger, more profitable ones with access to capital, it can be a strain.

Greater consolidation would give European airlines the resources and strategic flexibility to thrive in increasingly unpredictable, challenging times. Yet, resistance continues, despite the fact that European consolidation need not and probably won’t mirror American restructuring.

The European difference

First, for even the weakest European airlines, valuations are nowhere near the distressed levels that some US carriers faced a decade ago. Although European industry profit margins were more than four percentage points behind those of the US industry in 2017, European airlines overall achieved a 6.8 percent margin that helped maintain market value.

Europe is also not the United States. While the European Union may function as a single market, differences in culture and language cannot be ignored, even in business. For Europe, most consolidation efforts will require multiple air operator certificates (AOC), in contrast to what happened across the Atlantic.

For too long, some carrier groups have passed up what should be the most valuable, if challenging,

points of integration. Many have allowed customer experience, operations, and technology guidelines and mandates to be set and managed by the various operating carriers in their group rather than by the consolidated management.

Service synergies

To create revenue and cost synergies, European consolidations will need to work harder to realize corporate integration, operational harmonization, and centralized administration and governance. Group-level activities will evolve from holding companies to shared-service organizations and maybe even to single commercial entities that deal with revenue.

Shared services will include not just fleet planning and procurement, but also core activities such as maintenance and engineering; operational areas such as crew planning; and commercial functions such as product design, pricing, sales, and marketing. A few carrier groups are already working toward realizing these synergies, but most still have a long way to go.

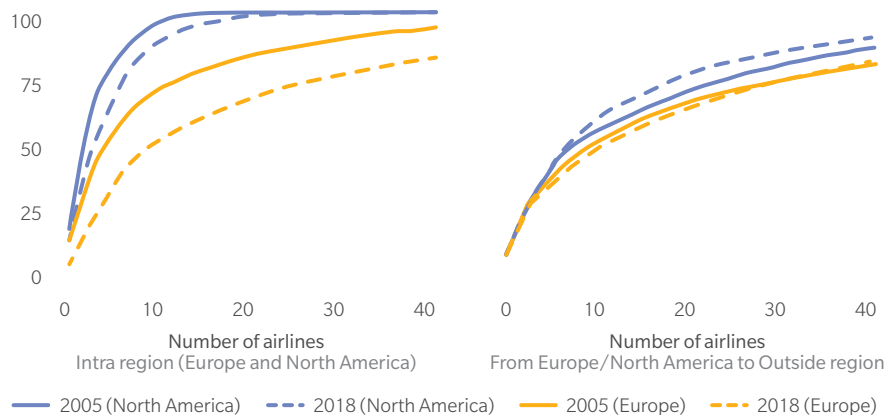
Certainly, some functions may be split into groups in cases where business models are materially different, such as captive low-cost or regional carriers. This will allow carriers to realize the benefits of scale, preserve the requirements of the business model, and meet local market needs.

Further capacity rationalization may come from asset purchase agreements rather than mergers, reducing the governance challenges. However, absorbing a

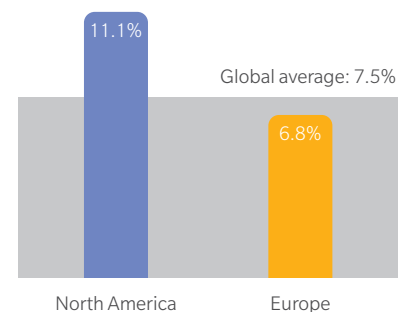
THE FINANCIAL IMPACT OF CONSOLIDATION GOES RIGHT TO THE BOTTOM LINE

THE NORTH AMERICAN INDUSTRY IS MORE CONSOLIDATED THAN EUROPE’S – AND MORE PROFITABLE

Cumulative available seat kilometers (ASKs) share by airlines across regions



Airline profit margin (2017)



Source: PlaneStats.com, Airline schedule data, IATA industry statistics

distressed asset or partial franchise often carries a greater near-term cost.

This evolution from holding company to greater shared services has the potential to become “asset light.” European carriers may leverage their network management expertise and contract the flying to independent operators, similar to US-style capacity purchase agreements or contract manufacturing.

The Latin touch

For a more appropriate model, Europe might look to consolidation efforts in Latin America. The 2009 Avianca-TACA merger shows how airlines can overcome differences in labor structure, corporate culture, and national pride to embrace a shared vision of brand and customer experience. The merged Avianca operations became a pan-Latin American network carrier after addressing the daunting challenge of migrating six airlines into a single modern maintenance and engineering organization. Key corporate, commercial, and administrative functions are centralized in Bogota, Colombia, while El Salvador remains a major hub where the operations control center is housed.

Most airline mergers over the past decade have realized revenue and cost synergies valued at three to seven percent of combined revenue from the merged carriers. While market overlap and carrier maturity certainly influence the value realized, the key factors are management’s resolve and employee engagement. Both help create the vision for how consolidation benefits passengers, the company’s viability, and growth

prospects. This commitment to greater integration has enabled Avianca to achieve total synergies worth about seven percent of revenue.

Even with the consolidation that has already taken place over more than a decade in Europe, there is room for more. Although various governments continue to resist efforts to consolidate by propping up flag carriers, critics should remember that the domestic service and jobs lost with the consolidation are often replaced by healthier carriers with better growth prospects. Finally, a more ambitious model for multi-AOC integration will enable the European carriers to realize the benefits from scale, capacity discipline, and profitability that will allow them to make the big investments required to not just survive but thrive in the future.

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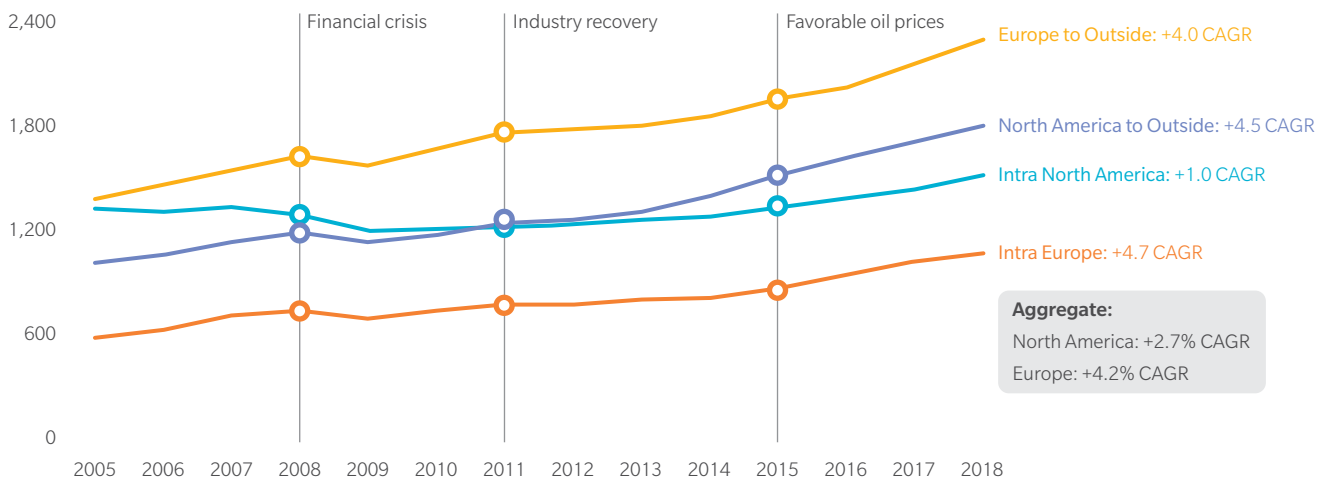
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CONSOLIDATION KEPT CAPACITY GROWTH IN CHECK IN NORTH AMERICA

NORTH AMERICAN CAPACITY INCREASED AT A MUCH SLOWER PACE THAN EUROPE



Source: PlaneStats.com, Airline schedule data

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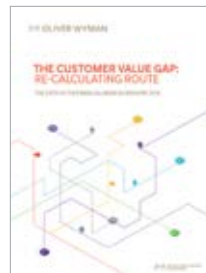
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