

VELOCITY

The Journal of Travel, Transport & Logistics 2019

TO OUR READERS

THE MOBILITY SECTOR is likely to see as much change in the next decade as it confronted in the last 100 years—a time when cars were mass-produced for the first time, commercial aviation was born, and humans traveled to the Moon. New transportation technologies will not only change how we move ourselves and our things but also how we live. Over the next 10 years, the global economy can expect the arrival of the first fully autonomous vehicles, the mainstreaming of electric cars and trucks, the advent of hyperloops, and the commercialization of drone transport for goods and eventually people. And those are the innovations we know about.

This transformation presents significant opportunities for nations and companies to move beyond a carbon-based economy and embrace the future. Those able to adapt can win new customers and sources of value; those that cannot will risk disruption as competitors, customers, and regulators leave them behind. While none of this will be easy, it has become necessary in the face of mounting congestion from unprecedented urbanization and the wildfires, droughts, hurricanes, glacial melt, and severe floods that remind us daily of the impending climate crisis.

VELOCITY is dedicated to understanding this future through articles that explore the increasing role of Chinese innovation in mobility, the hurdles to commercial drone transport, and how aviation hybrids can bring electrification to aircraft and reduce greenhouse gas emissions. The journal also examines the impact of new mobility technologies on the planet's increasing congestion problem, whether in cities or the national airspace.

We invite you to read our insights and provide us feedback. At the back of the journal, please find contact information for the partners who authored these articles. We look forward to hearing from you to discuss your ideas on what can be both an exciting and perilous future. Of course, which way it goes is up to us.

Jean Pierre Cresci and Taylor Cornwall

EDITORS

Pat Wechsler, Velocity Editor in Chief
Rebekah Bartlett, Senior Editor

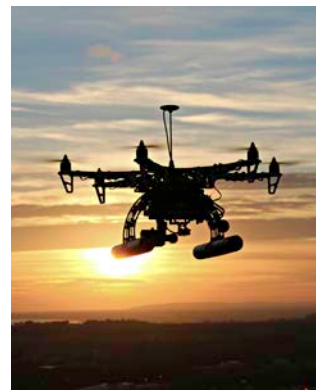
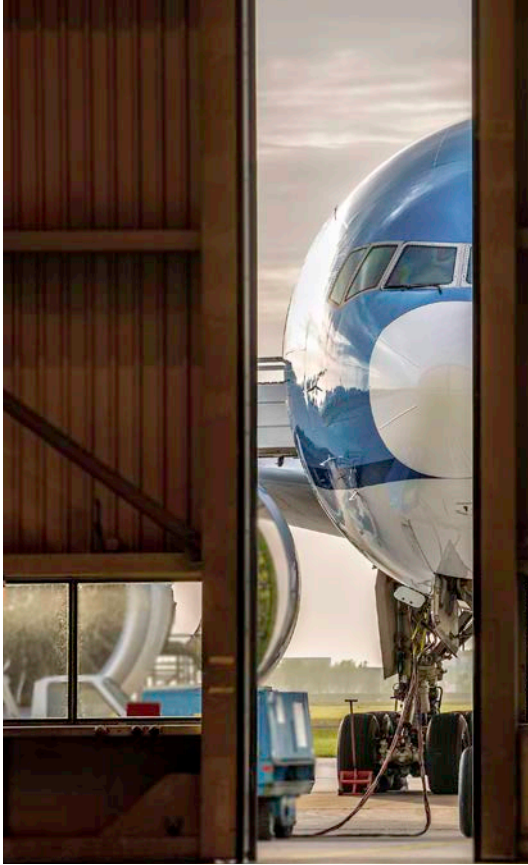
EDITORIAL & MARKETING COUNCIL

Birgit Andersen, Marketing Director
Jean Pierre Cresci, Partner
Taylor Cornwall, Partner

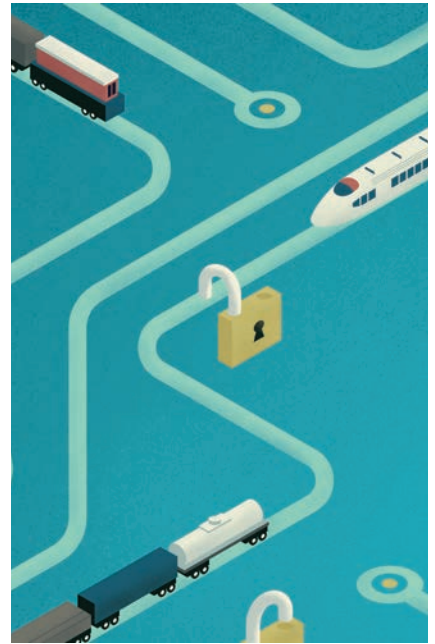
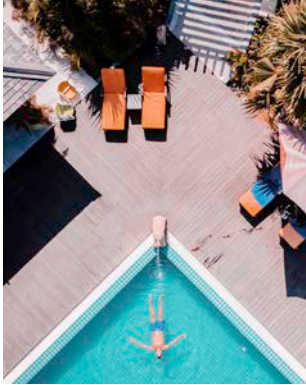
DESIGNERS

Campbell Reid, Creative Head
Melissa Ureksoy, Art Director
Ewelina Turkot, Senior Designer
Yireli Pale, Designer
Lorena Mondragon, Illustrator
Karen Lara, Illustrator
Timothy Fadek, Senior Photo Editor

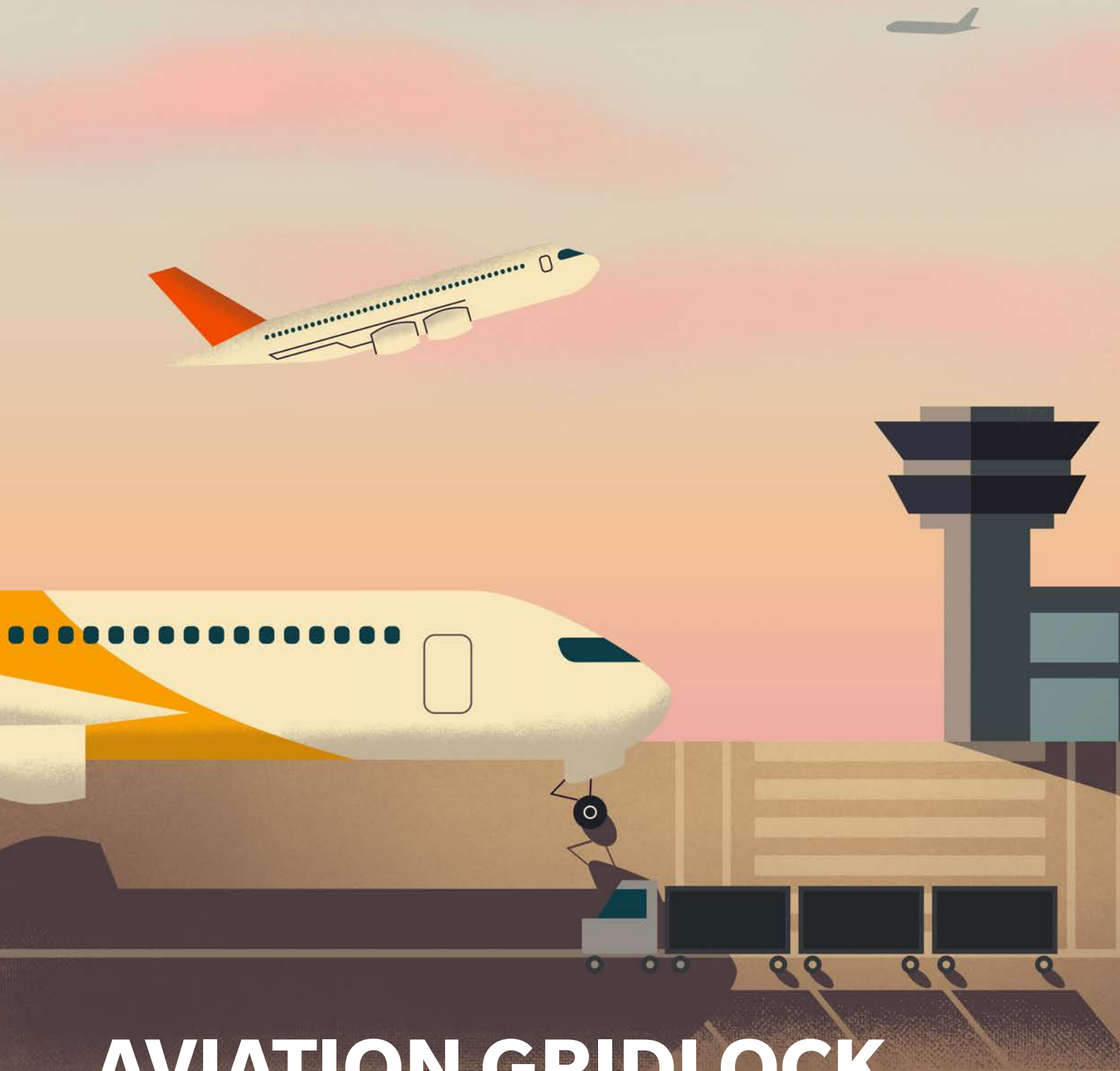
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AVIATION GRIDLOCK

With European skies and airports resembling London's M25 at rush hour, airlines struggle to cope with congestion

Taylor Cornwall • Michael Khan

IN 2018, EUROPEAN airlines flew a record 11 million flights, and they are setting records daily this year. While this sounds like cause to celebrate, the growth over the last several years has helped create an increasingly congested and challenging operating environment that even recent airline bankruptcies and aircraft groundings have not abated.

Airspace and airports are clogged by the rising number of arriving and departing aircraft. Airliners must wait their turn for gates, for ground personnel, for maintenance, and to take off. Not surprisingly, European airline punctuality fell in 2018 for a fifth straight year, sinking to a 10-year low. Last year, nearly one in four flights arrived late by 15 minutes or more, and delays of greater than an hour jumped 25 percent. Year over year, cancellations rose 35 percent.



Even minor timetable deviations now risk gridlock across the system

After years of deterioration in the European aviation environment, the strain is becoming unsustainable, especially with the growth expected in air travel over the next two decades. In an industry in which small delays can quickly propagate across a continent and across the globe, scheduling disruptions can no longer be easily tolerated. Even minor timetable deviations now risk gridlock across the system, bringing along associated personal, economic, and environmental costs.

A global problem

When it comes to congestion, the focus is on Europe, thanks to the monetization of the problem under stiff penalties imposed by Flight Compensation Regulation 261/2004, known simply as EU261. But the reality is airport and airspace overcrowding are challenges faced worldwide. On-time performance has suffered the past several years, especially in North America, where more than one-quarter of flights are late. In Asia, where much of the anticipated growth in air travel will happen,

on-time performance by percentage is also only in the mid-seventies. China, in particular, has plans to build new airport capacity, but accommodating the expected boom may still put strain on the system.

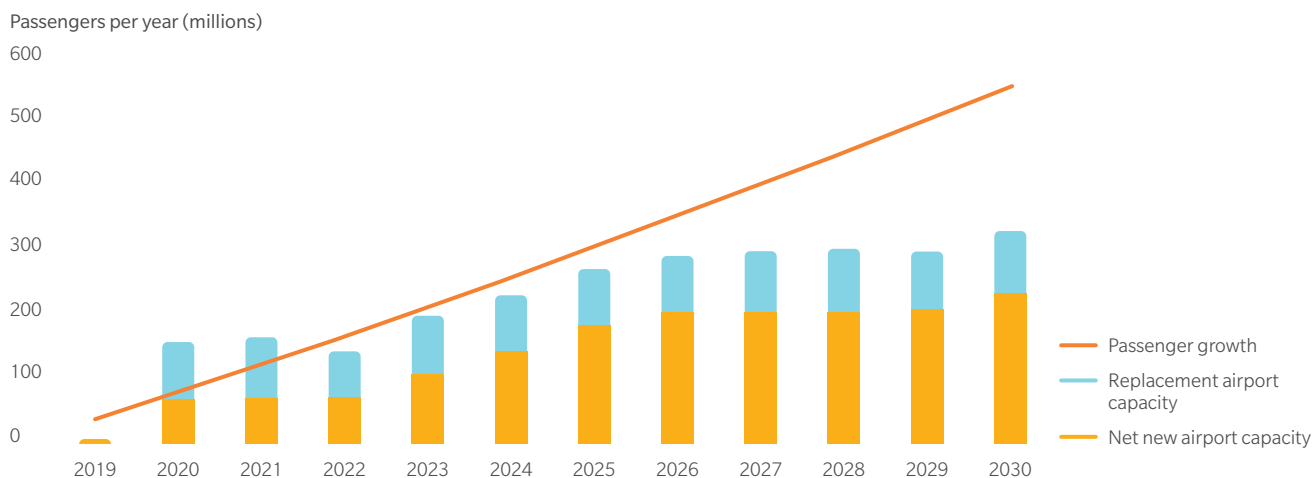
Just as in Europe, governments worldwide are stepping in with rules to protect consumers from the inconvenience, discomfort, and economic loss that accompany delays and cancellations. Like EU261, these measures often provide for regulatory fines, penalty payments to customers, and the provision of hotels, meals, and alternative travel for delays, cancellations, and overbooking. The most recent: Canada put into effect a passenger bill of rights in 2019 that's similar to, but less punitive than, EU261. And this summer the US Congress began considering similar legislation.

But a real solution to the problem requires more than simply finding ways in the near term to mitigate the pressure points and disruption. The aviation industry will need to work with its governmental partners, airports, and air traffic management to create a long-term balance between growth and operational efficiency. It will also necessitate substantial investment in both physical infrastructure and the deployment of a digital system that foresees and prevents disruptions globally—or at least helps airlines recover quickly when major delays occur.

Insufficient expansion

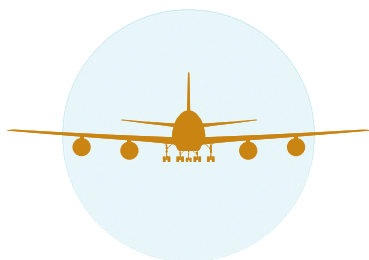
At the heart of the problem is a long-term misalignment of demand growth versus infrastructure investment: Too many passengers and too many flights without the

THE GAP BETWEEN AIRPORT DEVELOPMENT AND INFRASTRUCTURE NEEDS



Source: BMI Research, Oliver Wyman analysis

COSTS OF INCREASED CONGESTION



AIRLINE

- EU261 penalties and welfare
- Excess fuel burn
- Additional crew and ground staff pay
- Lost revenue from cancellations
- Contingency costs (standby aircraft, crew)
- Schedule inefficiencies (padded block time, excess turns, reduced aircraft utilization)

PASSENGER

- Cancelled plans
- Excess travel time
- Higher ticket prices
- Fewer travel options
- Travel anxiety

ECONOMIC & ENVIRONMENTAL

- Inefficient travel time
- Cancelled and forgone trips
- Carbon emissions from excess fuel burn
- Cost to manage complex system

Source: **Oliver Wyman analysis**

expanded capacity to serve them creates congestion. The number of airports in Europe considered highly constrained—think of the constant congestion of London’s Heathrow Airport—is projected to rise from six in 2016 to 16 by summer 2040, according to the European Organization for the Safety of Air Navigation, commonly called Eurocontrol. The average summer delay is expected to rise 63 percent to 20 minutes per flight.

This is the case despite the more than \$55 billion (€50 billion) expected to be invested in over 100 airport projects from 2019 to 2030. The new space will accommodate 240 million more passengers by 2030, up over 11 percent from the current volume of 2.1 billion—but the improvement will be spotty. Much of the new capacity is being added in Southern and Eastern Europe, leaving busy Western European hubs with limited growth options. Additionally, at least a quarter of the spending will go to replacing airports in Istanbul and Berlin.

Bottom line: The investment in European airports is just not enough. Assuming a modest two percent annual growth in air travelers, the net new airport capacity will meet less than half of the anticipated passenger demand by 2030.

The cost of congestion

For airlines in Europe, the increasing gridlock is exacerbated by the EU261 penalties. In total, these fees are costing carriers hundreds of millions of euros per year and eating into profitability. In an industry that has seen 10 bankruptcies in the past three years, the added costs from expanded schedules, operational

inefficiencies, and penalties tied to rising congestion may shave already thin margins.

With load factors above 80 percent most of the year and above 90 percent on summer flights, cancellations severely affect business and leisure plans. In 2018, at least 25 million passengers were inconvenienced when flights were canceled, and an additional 50,000 customers were delayed one to two hours.

Two decades from now, nearly a half-million passengers per year are likely to experience delays of over an hour. Airlines estimate the broader economic cost of congestion to be up to \$18.7 billion (€17 billion) per year, in addition to the more than one million metric tons of avoidable carbon dioxide emissions released while aircraft circle aimlessly waiting for an opening to land or run their engines on the tarmac before finally taking off.

Necessary remedies

Unfortunately, there is no quick fix to congestion, except for cutting back air travel significantly. That might be a plus for the environment, but it would push the cost of air travel up substantially as demand far outstrips supply, ultimately pricing out many in the broader public.

Any solution will require the industry to work closely with policymakers and fundamentally rethink how they address the problem. First and foremost, the industry and public sector must play catch-up with a front-end loaded, long-term plan for expanding and modernizing airport capacity that begins now, not five years from now. Moving forward, airport investment needs to keep pace with expected demand. That would help reduce ground congestion and the delays it creates in the air.

At the heart of the problem is a long-term misalignment of demand growth versus infrastructure investment

Measures like privatizing airports or private-public partnerships can help spur growth. Logjams only become more extreme when expansions get caught up in politics—like when it took 15 years to build a third runway at London Heathrow or the nine-year delay to expand Berlin’s airport. At the same time, airports need to support airline efforts to carry more passengers per flight, reducing the need for new flights.

Improving efficiency

In addition to creating new capacity, existing resources can also be used more efficiently. The focus must be on upgrading gate utilization and cutting pinch points. Recent developments in biometrics and automated airport processes may help get customers and luggage from curb to gate more quickly. But these technologies will require significant investment.

There is also the opportunity to better utilize European airspace. While proposals to do this have been in discussion for almost two decades, meaningful progress on the Single European Sky—a plan to overhaul the fragmented European air traffic management (ATM) system—offers a key to unlock this trapped capacity. One of the most promising efforts is the SESAR Joint Undertaking, formally the Single European Skies ATM Research, which is coordinating European Union research on ATM.

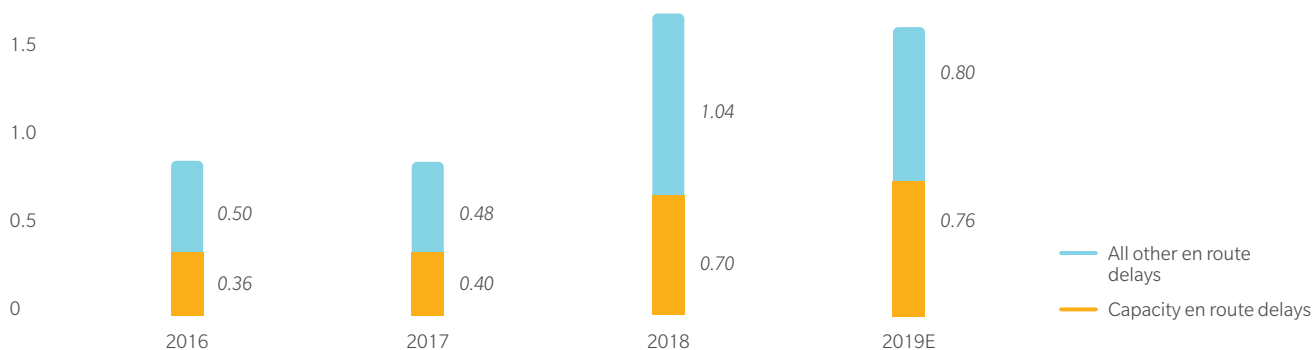
Additionally, alternative flight-planning strategies, a greater emphasis on “fly what you file,” and implementation of common data and tools through SESAR offer the potential to improve routing efficiency and reduce en route delay minutes. This should be paired with a renewed look at air traffic control staffing and labor relations.

Fixing the organization

Even with progress on these fronts, it will take time to produce better results. That’s why airlines must also invest internally to increase their own resilience. The focus here must be on creating a healthy balance between operational efficiency and revenue generation, which means tearing down departmental silos that block meaningful communication and data sharing. This would improve efforts to better anticipate delays and cancellations by using predictive analytics and shared real-time data so that contingency plans can be made in advance.

WORSENING EUROPEAN AIRSPACE CONGESTION

Average en route delay minutes per flight



Source: Eurocontrol, OW analysis

A SAMPLING OF REGULATIONS WORLDWIDE ON AIR DELAYS AND CANCELLATIONS

	COVERED INCIDENTS	PENALTIES AND COMPENSATION
1999 MONTREAL CONVENTION (VOLUNTARY) INTERNATIONAL AIR TRANSPORT ASSOCIATION INTERNATIONAL	Air disasters, lost luggage	Limited monetary compensation
2005 FLIGHT COMPENSATION REGULATION (EU261) EUROPEAN UNION	Cancellations, extended delays, denied boarding	Monetary compensation, free meals and refreshments, free hotel, free Wi-Fi or calls
2010 US DEPARTMENT OF TRANSPORTATION (DOT) UNITED STATES	Denied boarding, extended time on tarmac	DOT fines, free meals and refreshments, limited monetary compensation
2017 NATIONAL CIVIL AVIATION AUTHORITY BRAZIL	Lost luggage, cancellations, extended delays, denied boarding	Monetary compensation, rebooking and refunds, free meals and refreshments
2019 AIR PASSENGER BILL OF RIGHTS CANADA	Cancellations, extended delays, denied boarding	Monetary compensation, rebooking and refunds, reimbursement of fees, free meals and refreshments, free hotel accommodations, free Wi-Fi
2019 MINISTER OF CIVIL AVIATION INDIA	Delays, cancellations, overbooking, flight diversion lost, delayed or damaged luggage	Refunds, rebooking monetary compensation free meals and refreshments free hotel accommodation

Source: **Oliver Wyman Analysis**

Optics are important here, too. Delays and cancellations will always be a reality of travel, but as transparency increases through regulation, how airlines respond to disruptions will help define their market images, regardless of where they operate. Around the world, improving reliability has the potential to influence customer choice and ultimately revenue. A 2018 passenger survey by the International Air Transport Association indicated a stunning 90 percent correlation between on-time performance and satisfaction.

Thriving in the current environment means prioritizing congestion as a threat that airlines around the world dare not ignore. By improving organizational collaboration, upgrading to the most advanced predictive analytics, and bolstering overall resilience, airlines will deploy their best defense against that threat.

Taylor Cornwall

is a Dallas-based partner in Oliver Wyman's transportation and services practice and its digital practice.

Michael Khan

is a London-based partner in Oliver Wyman's transportation and services practice and its pricing, sales, and marketing practice.

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Jet contrails contribute to climate change by creating cirrus clouds that trap heat

FLYING HYBRIDS

Aviation could take a page out of the auto industry playbook for faster progress on emissions

Jerome Bouchard • Eric Confais



SINCE THE 1950s, aerospace has made incredible progress in increasing the power and efficiency of engines. Yet, recent studies suggest engine technology may be close to the thermodynamic limits on the energy it can extract from carbon-based fuel at a reasonable investment. That means more travel and more aircraft will lead to increased fuel use and more greenhouse gas (GHG) emissions unless a suitable substitute for fossil fuel is found.

Today, the global aviation industry accounts for 2.4 percent of total carbon dioxide emissions and about 12 percent of the greenhouse gases released by the transportation industry. But those percentages are expected to increase as demand for air travel, particularly in Asia, requires the addition of substantially more capacity. By 2029, revenue passenger kilometers could jump more than 60 percent to 12 trillion, and the size of the global fleet is expected to expand 42.5 percent to over 39,000 aircraft.

By 2050, the International Civil Aviation Organization (ICAO) predicts emissions from aviation could grow more than 300 percent. With that kind of increase, it's likely the industry's share of total greenhouse gas emissions will climb if no meaningful attempt is made to turn away from fossil fuels—especially given the success that other carbon-emitting sectors, such as electricity generation, have had switching to renewable energy sources.

Interim solution

Because a complete solution to the emissions problem—a commercial jet powered entirely by something other than fossil fuels—is probably decades away, a few pioneering aerospace companies are borrowing an idea from the automotive industry and working to create hybrids. Just as they did for cars, these propulsion systems—part internal combustion and part electric—could represent an interim strategy to cut emissions and fossil fuel consumption until fully sustainable electric or hydrogen-powered aircraft are

developed. Given mounting evidence that the pace of climate change is accelerating, aviation can ill afford to wait two decades to address its emissions problem.

While hybrid automobiles don't reduce emissions as much as fully electric vehicles, they do cut them almost in half compared to gasoline-powered cars. For aviation, going hybrid would still mean overcoming many engineering challenges and would require regulatory approval, but this alternative could be realized sooner than a fully electric airliner.

Research into the electrification of transportation is part of the global effort to avert large-scale drought and rising sea levels by reducing greenhouse gas emissions. While most nations and industries have pledged to do their part, carbon dioxide emissions continue to rise—up 2.7 percent last year, according to a Global Carbon Project report. Numbers from the International Air Transport Association show aviation emissions up 26 percent since 2013. With the pressure to stabilize the situation, aviation needs to come up with solutions in the next few years or face penalties under the United Nations-sponsored agreement titled the Carbon Offsetting and Reduction Scheme for International Aviation.

With electric cars and light vehicles not expected to dominate auto sales until 2040, Emissions Analytics, a global testing and data specialist that measures real-world emissions and fuel efficiency, has argued that promoting hybrids in the short term may be more effective at cutting emissions over the long run. Why would not the

same be true for aviation, given how elusive complete electrification of air transport is proving?

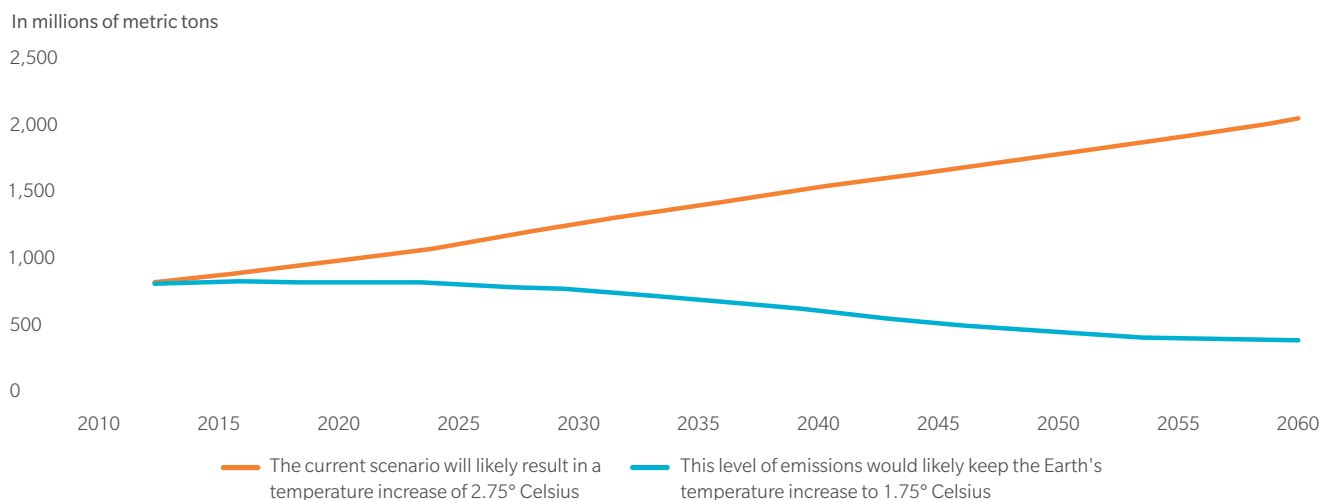
Working the problem

Representing a step toward lower emissions, hybrids are powered by both conventional kerosene-fed turbine engines and electric motors using "clean" power stored in batteries or produced by hydrogen fuel cells. This dual-technology propulsion system would be usable through all phases of flight, and besides lowering emissions, it would likely cut an aircraft's consumption of jet fuel—the second biggest operating cost for airlines.

At least one small-scale attempt to assign some engine functions to electric motors has already been successful, but unfavorable economics stopped it from being adopted. In 2016, Safran Landing Systems and Honeywell abandoned an electric taxiing system that would have cut emissions and fuel use, especially for airlines that focus on frequent, short-haul flights. Low fuel prices made the system less attractive to carriers.

There have also been test flights of small hybrid aircraft. Among them, the University of Stuttgart's e-Genius plane conducted at least two successful flights over the Alps using a relatively complex propulsion system consisting of an electric motor, batteries, a generator, and an internal combustion engine. Similarly, Diamond Aircraft Industries and Siemens announced the first flight of a multi-engine hybrid electric aircraft late last year.

ASSUMING CURRENT POLICY AND NO MAJOR TECHNOLOGICAL ADVANCES, AVIATION CO₂ EMISSIONS WILL CLIMB



Source: International Energy Agency, *Energy Technology Perspectives 2017*. www.iea.org/etp2017

More ambitious hybrid experiments are underway as well. Most recently, SAS and Airbus announced a collaboration to create a hybrid electric aircraft for large-scale commercial use. At the Paris Air Show in late June, hybrid projects were unveiled by Airbus, Safran, Daher, and Eviation, an Israeli startup. Rolls-Royce also announced its intention to acquire Siemens' eAircraft business at Le Bourget, another indication of growing commitments to an electric future.

Battery or fuel cell

Even with hybrids, there is a choice to be made between lithium-ion batteries, now commonly used in electric vehicles and smartphones, and hydrogen fuel cells. Each has advantages and drawbacks. For instance, lithium-ion batteries have a relatively low energy density per unit of mass compared with current kerosene-based jet fuel, meaning a larger and heavier battery is needed. With a hybrid, of course, that disadvantage is offset by the fact that the battery is backed up by a conventional internal combustion engine.

Battery recharging time also needs to improve for aircraft, particularly those that have just 30 minutes between flights. While a rapid-charging option has been in favor for electric cars, researchers are still trying to develop battery-swapping capability, despite early problems with the technology.

If battery-swapping succeeds for cars—an option with some economic and environmental concerns to overcome as well—it would allow a fully charged battery to be substituted for a dead battery in the time it takes to fill up with gasoline. It would also remove one impediment for battery use by aircraft.

Hydrogen power

Hydrogen fuel cells are another alternative being researched. The most abundant element on earth, hydrogen has higher energy density per unit of mass than either kerosene-based jet fuel or batteries—some 33,300 watt-hours per kilogram versus 11,900 for conventional jet fuel and only a few hundred for batteries. Within these cells, hydrogen and oxygen are combined electrochemically to produce electricity. Their only byproducts are heat and water vapor.

Three years ago, the HY4 — a four-seater using only an electric motor powered by a hydrogen fuel cell — successfully took off from the Stuttgart airport in Germany, staying airborne for 10 minutes. In Singapore, the world's first regional hydrogen-electric passenger aircraft was unveiled in October 2018. Although considered aspirational by many in the industry, the company has reportedly already received inquiries from regional airlines.

Aviation's share of global CO₂ emissions will climb if the industry fails to find workable substitutes for fossil fuel

Many aerospace executives privately discuss liquid hydrogen as the potential endgame for aircraft, emulating the propulsion design that the National Aeronautics and Space Administration (NASA) has used almost since the agency's inception to power its rockets. Recently, NASA funded a program at the University of Illinois that aims to develop a fully electric aircraft platform that uses cryogenic liquid hydrogen as an energy storage method. But for several years, the agency also has been researching the development of hydrogen hybrid aircraft.

But hydrogen has drawbacks. Since hydrogen doesn't exist on its own in nature, it needs to be separated from oxygen in water molecules or from carbon in natural gas. The technology to produce hydrogen and its storage can be pricey, and when separating it from natural gas, it ends up producing methane, another greenhouse gas.

Clearly, more must be done, and one of the biggest benefits of a hybrid strategy is that it may buy the aerospace industry the time it needs to create a flying machine that doesn't use fossil fuels at all. Given the absolute necessity to cut emissions, an industry hybrid strategy that focuses on incremental solutions raises the prospect of real progress on reducing emissions in the near term, even as air travel expands.

Jerome Bouchard

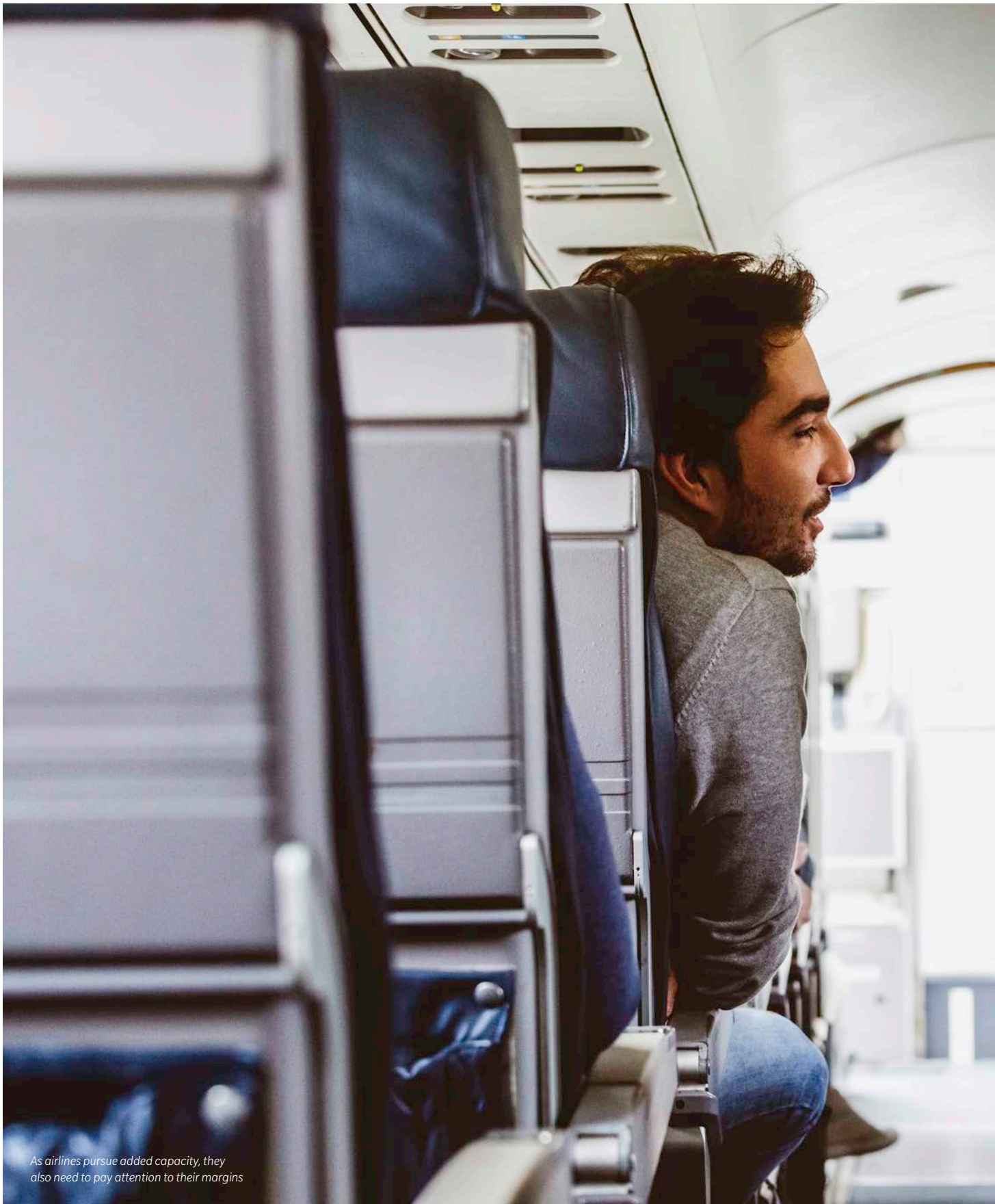
is a Paris-based partner in Oliver Wyman's transportation and services practice.

Eric Confais

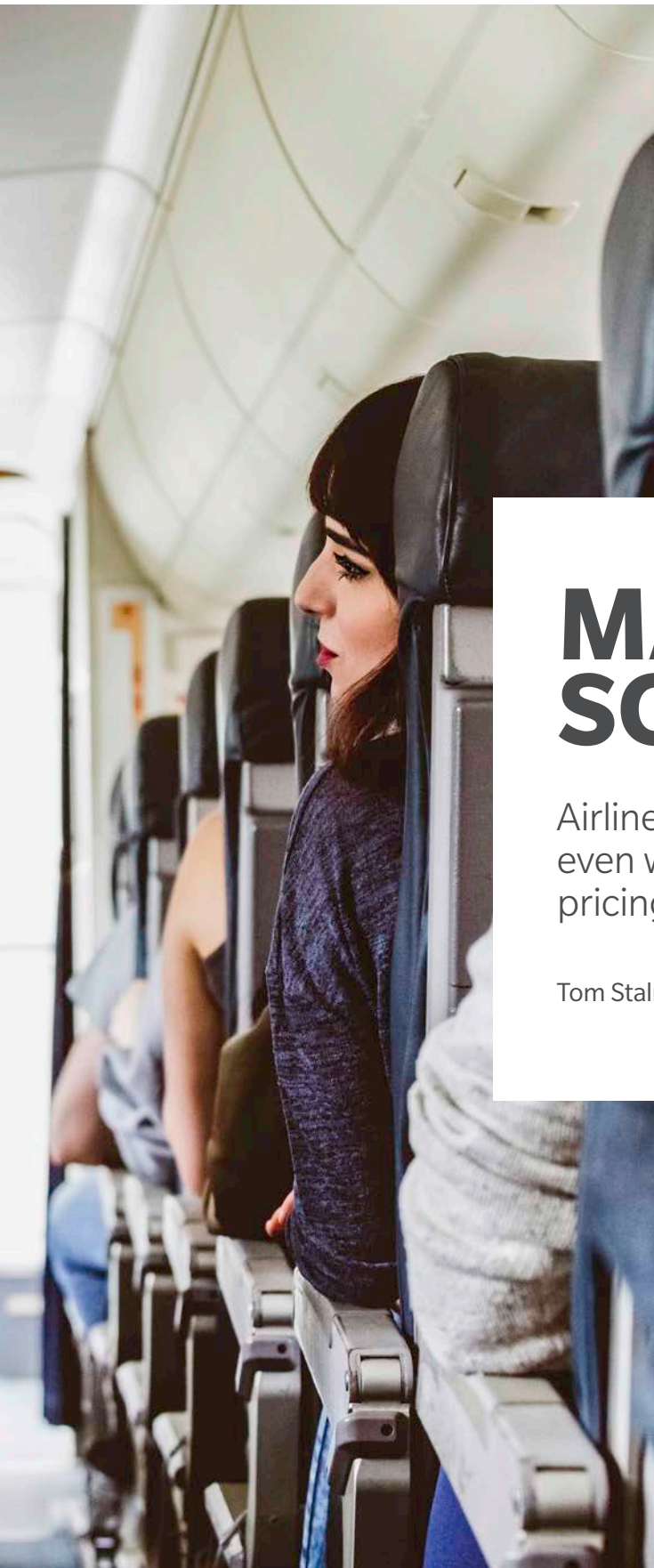
is a Paris-based partner in Oliver Wyman's energy practice.

Dave Marcontell, a senior vice president and general manager of Oliver Wyman CAVOK, and **Tom Cooper**, an Oliver Wyman CAVOK vice president, contributed to this article.

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*As airlines pursue added capacity, they
also need to pay attention to their margins*



MARGIN SQUEEZE

Airlines are adding capacity even when it means bad things for pricing, yields, and margins

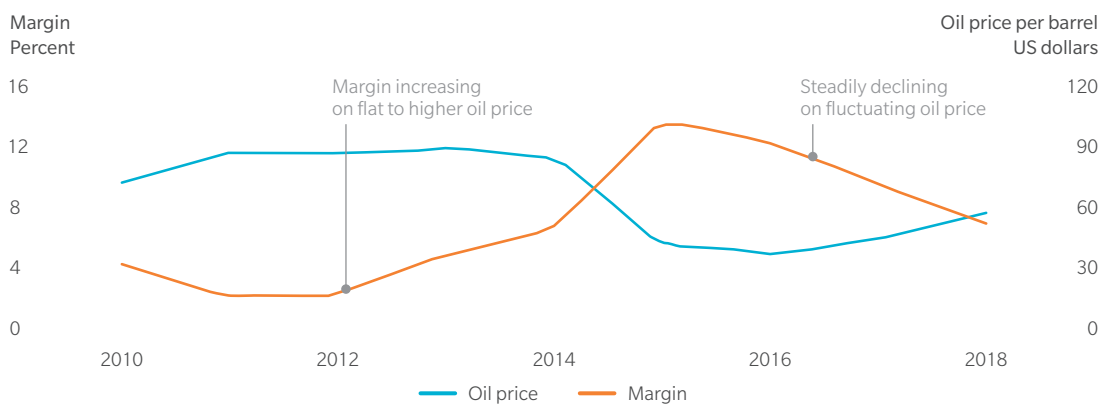
Tom Stalnaker • Grant Alport • Andy Buchanan • Aaron Taylor

DESPITE STRETCHING THEIR unbroken string of operating profits to eight years in 2018, airlines in the United States face tough choices today as costs rise and margins narrow. Persistently strong demand for air travel is pushing many carriers to add capacity, but the additional routes and service are making pricing more competitive and putting pressure on yields.

Based on current trends and pressures, the operating margin for US airlines is expected to narrow to between five and six percent in 2019—a margin that is less than 40 percent of the industry's peak of 15 percent in 2015. Given the potential for a global economic slowdown in 2019 and 2020, reversing the decline in profit margins will become more of a challenge.

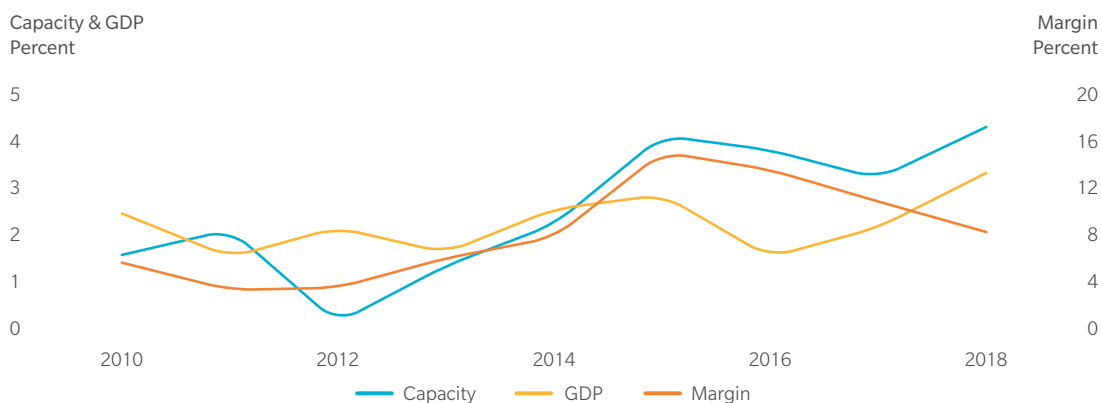
Margins were squeezed in 2018 as well. They fell to 9.2 percent from 12.7 percent the previous year, marking the third straight year that US airline margins have contracted. The calculations and analysis are based on research on 10 prominent US airlines for the [*2019 Oliver Wyman Airline Economic Analysis*](#).

US AIRLINE INDUSTRY MARGIN AND OIL PRICE PER BARREL THROUGH Q2 2018



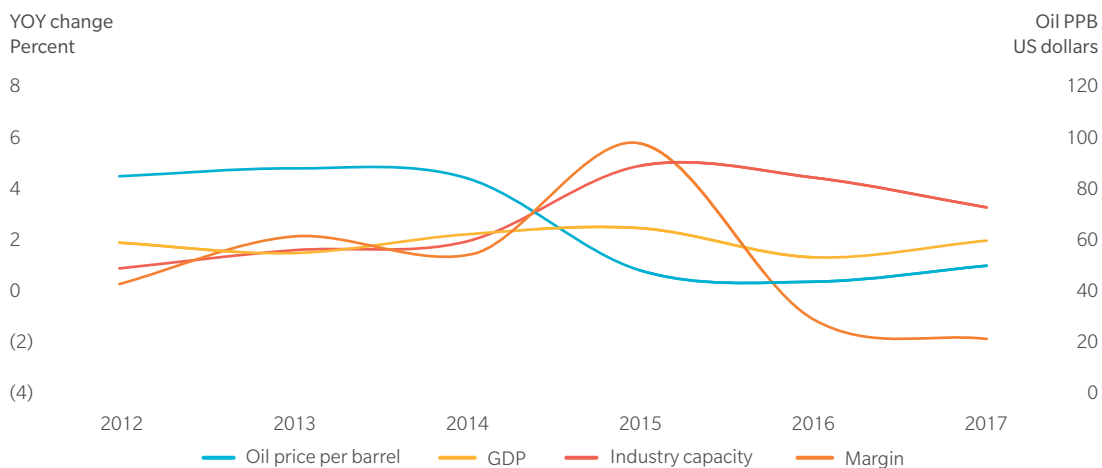
Source: Oliver Wyman analysis

US AIRLINE INDUSTRY MARGINS, GDP, AND AIRLINE CAPACITY THROUGH Q2 2018



Source: Oliver Wyman analysis

US AIRLINE MARGINS AND MACROECONOMIC INDICATORS



Source: Oliver Wyman analysis

New pressures

The additional capacity is also making it increasingly difficult for airlines to keep up their operational resilience and stick to published schedules. On-time performance in North America dropped to 74.5 percent in February 2019 from 78.7 percent in February 2018 and 81.5 percent in 2017. Additionally, the impact of capacity growth on an already severely constrained infrastructure and overly congested airspace and airports must be addressed.

Based on the global struggle to reduce greenhouse gas emissions, the airline industry will likely contend with mounting pressure from governments and the public to do its part, even as available seat miles and the number of flights increase. The global fleet is expected to grow 42.5 percent to more than 39,000 aircraft by 2029. Airlines will have to figure out a way to cut fuel usage as they grow capacity or face rising carbon offset payments under the Carbon Offsetting and Reduction Scheme for International Aviation.

Capacity growth

There's no doubt that the rising demand for air travel is encouraging airlines to focus on the need for new capacity and the potential to expand revenue and market share—even if such moves mean potentially sacrificing margins and reducing yield. This year's *Airline Economic Analysis* reinforces earlier findings that adding capacity at a pace faster than US economic growth has contributed to carriers' eroding margins over the past several years. This is a situation likely to continue until a balance between supply and demand is restored.

In 2014, capacity began to expand faster than the US gross domestic product (GDP)—much faster, in fact. That year, GDP grew 2.5 percent versus capacity growth of well above three percent. By 2015, capacity growth was peaking above four percent, while GDP was 2.9 percent. Industry margins reached 15 percent, helped by oil prices that averaged around \$50 a barrel.

GDP took a sudden slide in 2016 to below two percent as the US trade deficit ballooned and oil prices plunged. While airline capacity growth also began to slow, it failed to match the drop in GDP. That's when margins began to fall despite lower oil prices.

Even with cheaper oil

In January 2016, oil prices slid to around \$35 from a high of more than \$110 in 2014. Although prices per barrel quickly recovered to above \$50, they have not returned to the \$80-plus levels they had maintained between mid-2009 and October 2014. While fuel typically makes up between 25 and 30 percent of total operating costs for carriers and represents the industry's second-largest

The operating margin for US airlines in 2019 is expected to be almost 40 percent lower than its peak in 2015

expense, the pattern of margin decline makes it clear that many factors other than fuel—most notably labor, the No. 1 expense, and capacity—affect profitability as much or more over the medium to long term.

One caveat: While margins have tightened since 2015, they are still higher than they were from 2010 to 2013, when they were six percent or lower and oil prices were consistently above \$80. The fact that margins were in the teens from 2015 to 2017, even though on the decline, reflects the impact of lower oil prices.

While airlines remain profitable, the prospect of slowing GDP may force carriers to reassess capacity expansions, especially given rising pressures on operations from such rapid growth. Indeed, the industry's biggest risk over the next decade may be failing to strike the right balance between capacity and profitability at a time when managing operations grows increasingly difficult.

Tom Stalnaker

is a Washington, DC-based partner in Oliver Wyman's transportation and services practice and leads its global aviation sector.

Grant Alport

is a Washington, DC-based principal in the transportation practice at Oliver Wyman.

Andy Buchanan

is a Chicago-based vice president in the transportation practice at Oliver Wyman.

Aaron Taylor, a New York-based senior manager in the transportation practice, handles PlaneStats.com, Oliver Wyman's aviation business intelligence offering.

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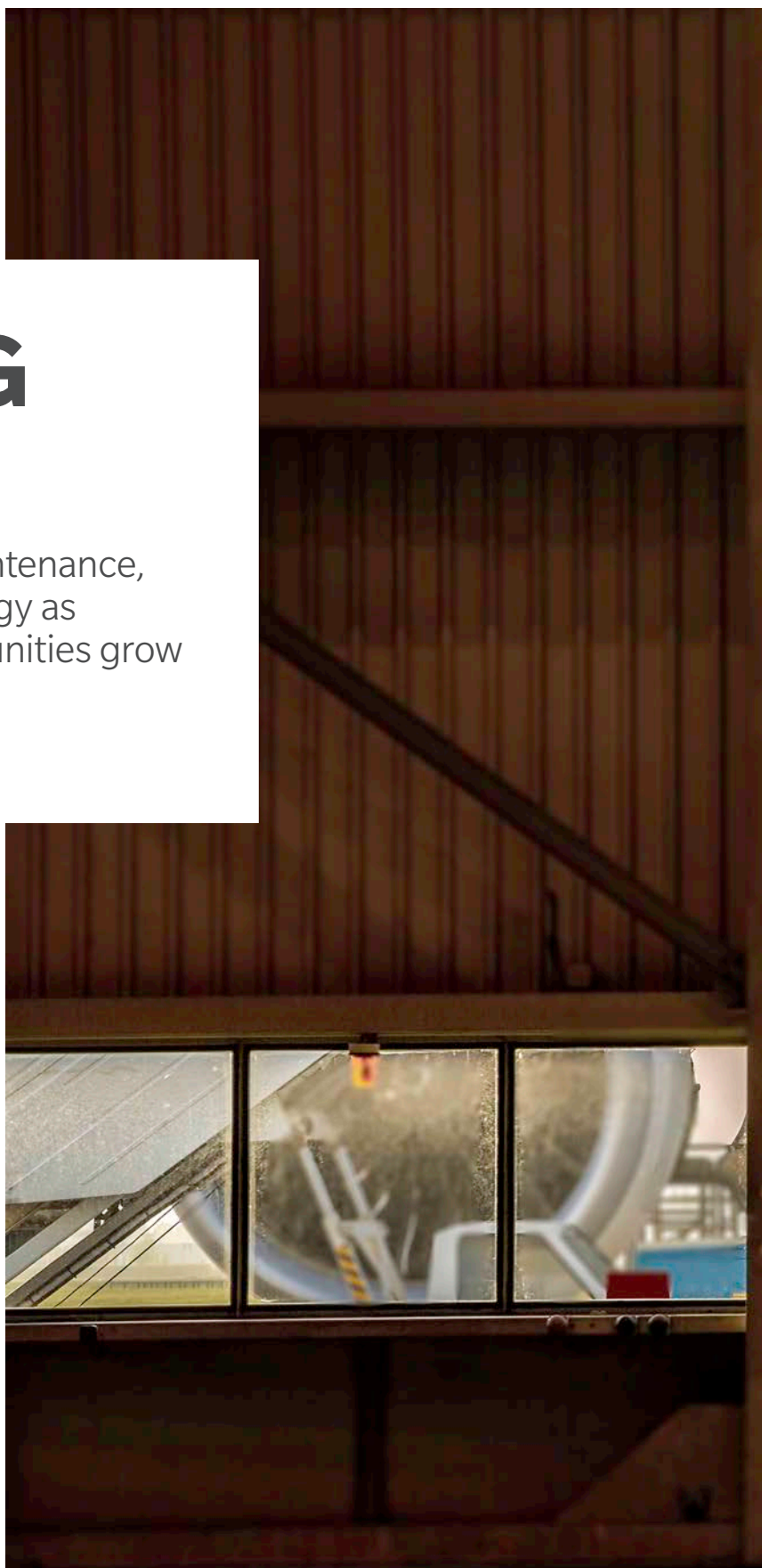
REVERSING COURSE

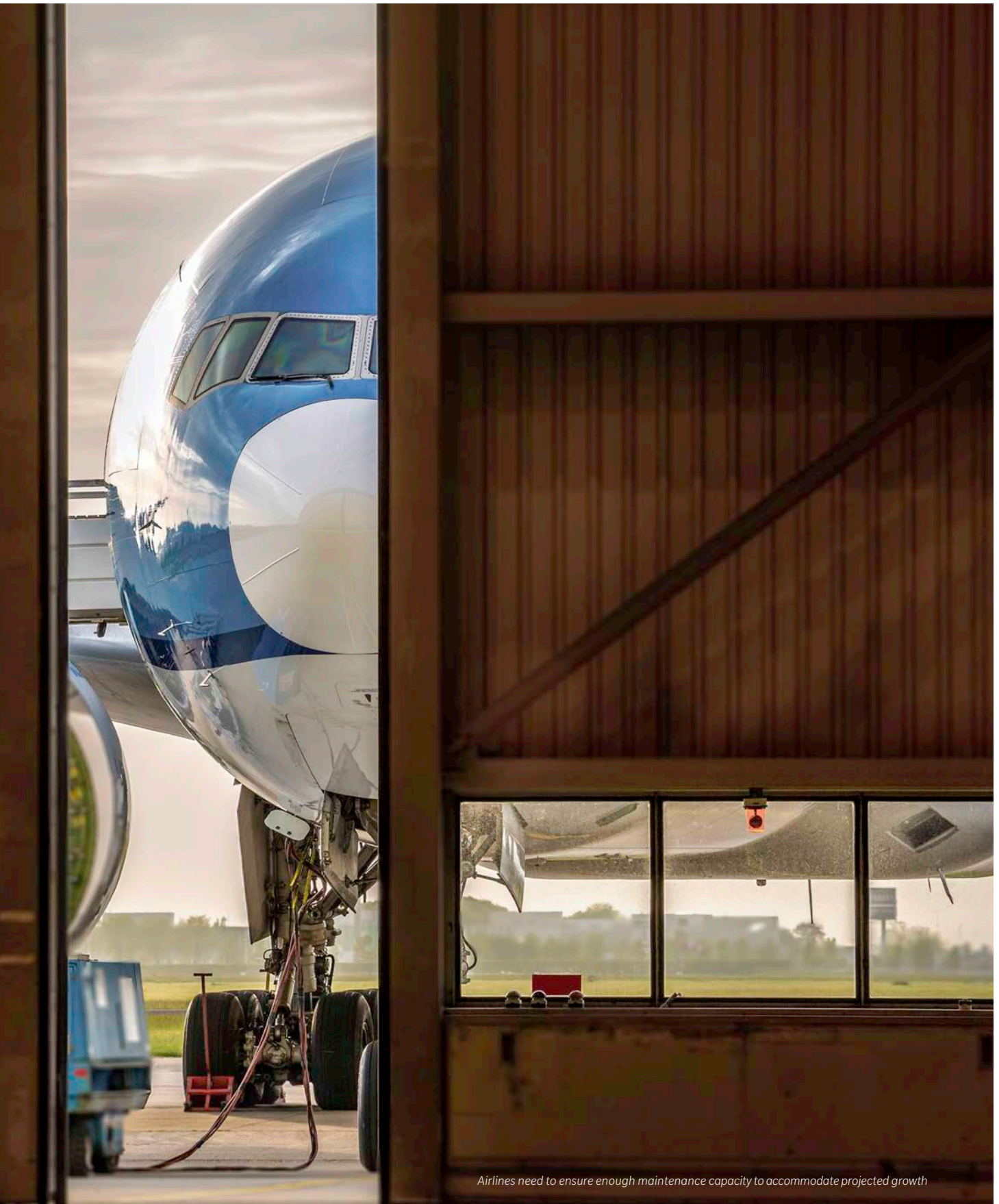
After years of moving out of maintenance, airlines are rethinking that strategy as competition shrinks and opportunities grow

Tom Cooper • Brian Prentice • David Stewart

FOR TWO DECADES, most airlines have stayed out of the business of aircraft maintenance and left the work to third-party providers—or, in recent years, aerospace manufacturers. There were plenty of independent service companies to keep rates relatively stable and ensure enough capacity to accommodate aviation's needs. But the maintenance, repair and overhaul (MRO) sector has been undergoing a transformation in recent years, and a plethora of pressures and emerging risks is beginning to convince airlines it may be time to get back into the aftermarket—another name for the MRO sector.

In recent months, the industry has seen a spate of announcements by airlines about plans to reinvest in MRO in-house capacity. In most cases, it has been to handle their own needs, but some airlines are also looking to create an increasing source of revenue by offering MRO services to other carriers.





Airlines need to ensure enough maintenance capacity to accommodate projected growth

Competitive squeeze

What changed? First, there are fewer independent MRO providers because of consolidation. With emerging technologies like predictive maintenance, it's getting more expensive for these firms to stay current. It's also getting harder to find mechanics capable of repairing the pre-2000 vintage aircraft, as well as those planes produced after the start of the millennium.

The biggest push behind consolidation came from aerospace manufacturing. Over the last few years, aerospace manufacturers have started to expand into MRO and assert their control over the intellectual property (IP) behind engines, components and airframes. This made life tough for smaller MRO providers, leading to consolidation.

Last year, the two biggest aircraft manufacturers, Airbus and Boeing, indicated they expect to exponentially increase their MRO business over the next several years. At the 2018 Farnborough International Airshow, Airbus said it would triple its revenue from MRO to \$10 billion in a decade. Boeing, already with a sizable revenue of more than \$16 billion in 2017, said it planned to hit \$50 billion in revenue over the next 10 years. Clearly, the aftermarket is never going to be the same.

Rising prices

In *Oliver Wyman's 2018 MRO survey*, 78 percent of industry executives said they expected aerospace manufacturers to expand their aftermarket presence over the next three years. A majority reiterated that expectation this year.

Most respondents in 2018 also suggested manufacturers, including airframe and engine makers, would do that by leveraging control over existing IP and licensing to boost market share. The question wasn't asked in this year's survey.

While there has been some competitive price-cutting on specific parts, the manufacturers' move into the aftermarket is expected to push up prices over the long run and reduce the number of competitors. Already, some carriers are reporting higher prices. And it was exactly the risks of rising prices and reduced leverage in negotiations that prompted some airlines to rethink their outsourcing strategy on MRO.

The second big threat that airlines see ahead—which is also the opportunity that makes MRO so attractive—concerns how fast aviation is expanding and expectations for growth of the aftermarket itself.

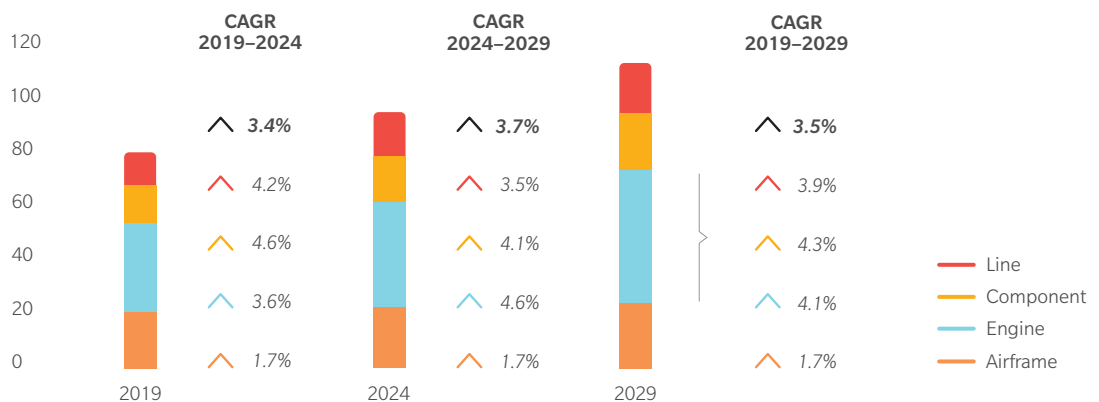
According to the *2019-2029 Oliver Wyman Global Fleet and MRO Market Forecast*, the global fleet of aircraft will grow 42.5 percent by 2029, when it will exceed 39,000 aircraft. With it, there will be a concomitant increase in aftermarket spend, up 41.4 percent to \$116 billion.

Insufficient capacity

The problem is whether the industry has the capacity to accommodate the growth. One of the biggest question marks is labor supply: There just aren't enough trained mechanics and other aviation maintenance technicians as baby boomers retire and too few millennials are recruited. Based on Oliver Wyman calculations, the shortfall will expand to more than nine percent in 2027, just as the fleet is reaching its peak size.

FUTURE GROWTH OF MRO

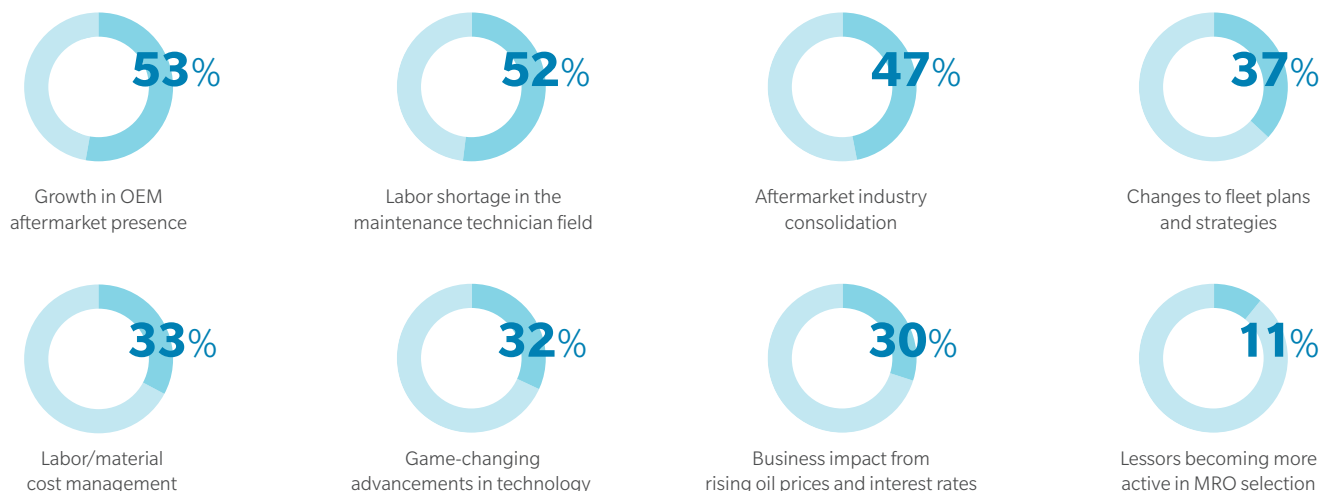
US dollars (billions)



Source: **Oliver Wyman**

SURVEY: REASONS WHY AIRLINES ARE MOVING INTO MRO

Percent of aviation industry respondents



Source: **Oliver Wyman** analysis

There is also a potential shortage in airframe and engine MRO capacity. To avoid being affected by these shortages, airlines reckon it may be best to have a sufficiently big in-house crew and facilities to handle a chunk of their own internal needs.

The pressure may be the greatest in Asia, where the growth will be the biggest because of the burgeoning middle classes in nations like China and India. That helps explain why two of the announcements for expanding MRO came from Air Asia and Malaysian Airlines.

Some never left

Of course, some airlines, such as Delta, Lufthansa and Air France-KLM, never left the maintenance business. They already have a track record as service suppliers to other carriers. Here, the shortage of supply—both capacity and labor—and the rising demand are encouraging the parent airline to grow that side of the business.

On Feb. 21, Delta unveiled a new jet engine test facility, reportedly the largest in the world. The airline said it hopes to expand its maintenance unit, Delta TechOps, by \$1 billion over the next five years. A key part of this expansion focuses on adding newer Rolls-Royce engines to its existing engine maintenance portfolio, a decision reflecting the need to ensure capacity and greater supplier choice for Delta, as well as an effort to increase third-party revenue. It also provides necessary maintenance capacity to handle new engines.

Airlines are caught between a contracting number of providers and mechanics and a significant growth in demand. With questions about the adequacy of capacity and the loss of leverage against manufacturer-controlled MRO, carriers have had little choice but to practice a little risk management that could turn into new revenue.

Tom Cooper

is an Atlanta-based vice president in Oliver Wyman CAVOK.

Brian Prentice

is a Dallas-based partner in Oliver Wyman's transportation and services practice and the operations practice.

David Stewart

is a London-based partner in Oliver Wyman's transportation and services practice.

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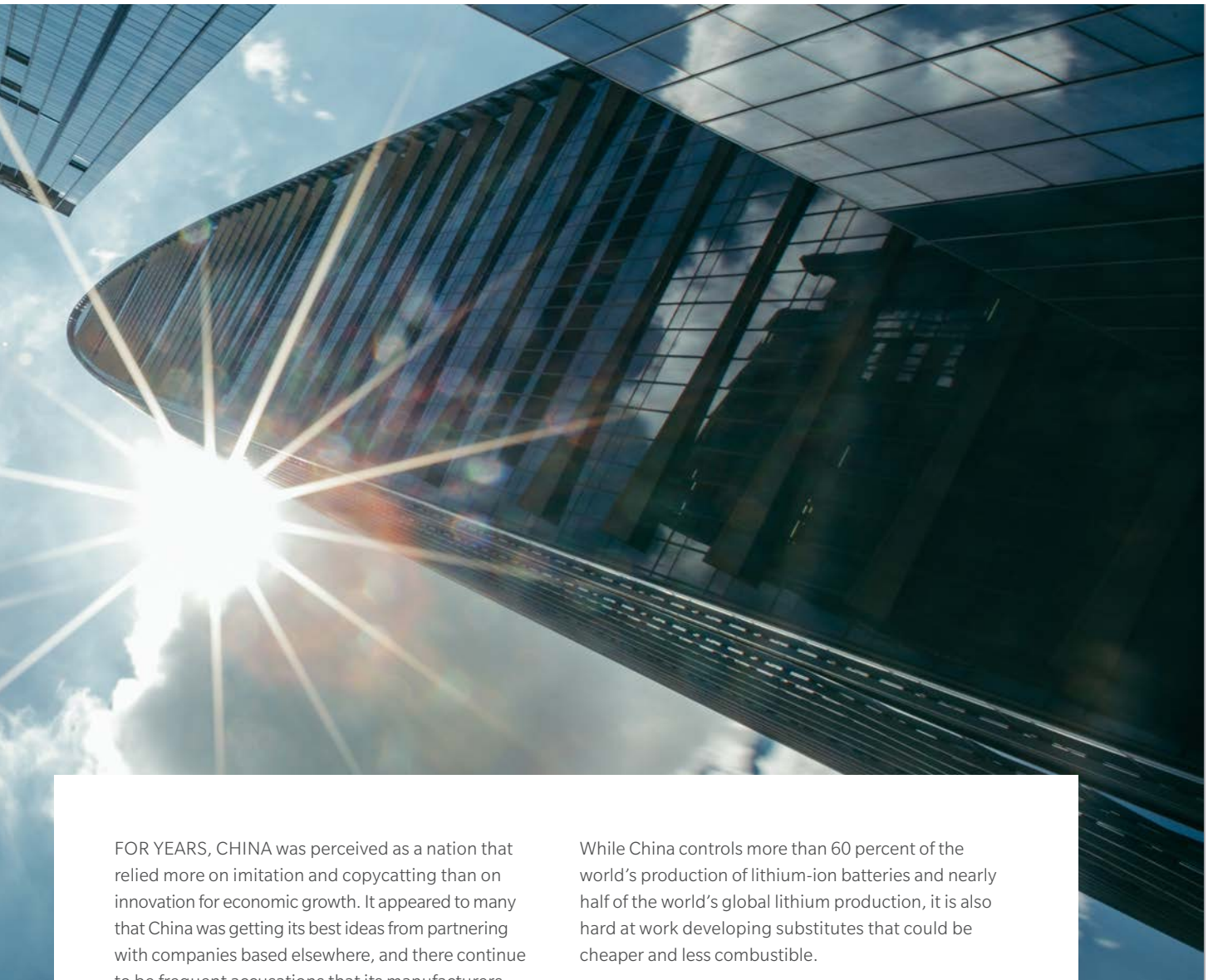


Shenzhen is home to internet giant Tencent, telecom giant Huawei, the world's leading drone manufacturer, and one of the world's top three lithium-ion battery makers

SILICON VALLEY EAST

Once called a technology copycat, China is now synonymous with mobility innovation

Heiko Rauscher



FOR YEARS, CHINA was perceived as a nation that relied more on imitation and copycatting than on innovation for economic growth. It appeared to many that China was getting its best ideas from partnering with companies based elsewhere, and there continue to be frequent accusations that its manufacturers don't respect intellectual property laws. While its high-volume, low-cost manufacturing prowess was never questioned, the line on China was that it could not compete when it came to innovation.

Those days seem to be behind us. In the 21st century, China is emerging as a leader in many new technologies—especially those related to mobility. The Chinese government has pledged to convert the nation into an international innovation leader by 2030, but in many ways China has already reached that status, certainly when it comes to electric vehicles, batteries, drones, and high-speed rail.

Today, China is not only the biggest producer of electric vehicles (EVs) by far, but also a leader in lithium-ion battery technology that powers EVs as well as smartphones and other mobile devices. Batteries are the power storage of the future as the world moves relentlessly toward the electrification of transportation.

While China controls more than 60 percent of the world's production of lithium-ion batteries and nearly half of the world's global lithium production, it is also hard at work developing substitutes that could be cheaper and less combustible.

Drone power

On multiple fronts, Silicon Valley and other US tech hubs are evenly matched—or trailing behind—the imagination and technical prowess of Chinese companies. As one example, Chinese drone producers are ahead of competitors in the development of autonomous systems for personal mobility, according to a 2018 World Economic Forum report. A Chinese-Austrian joint venture recently debuted a pilotless air taxi in Vienna that it said it would start producing in 2020.

China also announced its intention to build a national innovation center for high-speed rail in Qingdao and has been actively exploring the trackless tram, a cross between a bus and a streetcar that runs on rubber tires. Autonomous versions of high-speed rail have also been in testing for the last two years.

The Made in China 2025 initiative is at the heart of China's transformation

According to a study by the Information Technology and Innovation Foundation, China has closed the gap with the US in areas such as patents and top universities. In some areas like supercomputers, China is pushing ahead.

What has changed in China that made this transformation possible? Probably the biggest contribution to the country's technological surge was the strategic decision to invest heavily in research and development. Between 2000 and 2016, Chinese research and development investment grew on average 18 percent annually versus compound annual growth rates of four percent in the US and five percent in the European Union.

Unicorn territory

Thanks to this financial commitment to innovation, China has shown a dramatic increase in both its number of patent applications and patent grants. Back in 2000, China's number of patent applications was less than

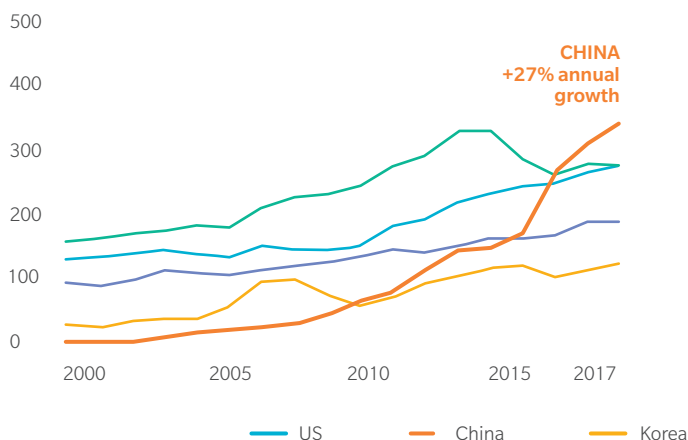
one-tenth the number in the US. By 2017, China's applications equaled the sum of applications in the US, Japan, and the top five nations in the European Union. And since 2015, China has been the worldwide leader in patent grants, based on data from the World Intellectual Property Organization and an Oliver Wyman analysis.

More than 40 percent of global unicorns—startup companies with a valuation of more than \$1 billion—were based in China in 2018, according to online technology news and analysis publisher TechCrunch. The 149 unicorns in China even beat out the 146 in the US, its closest rival.

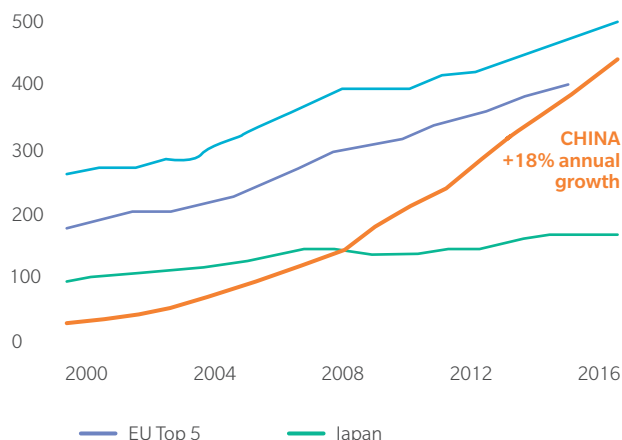
Made in China 2025, a state-led industrial policy aimed at making China into a leader in global high-tech and heavy industrial manufacturing, has been at the heart of the nation's transformation from copycat to innovator. The program, which involves sizable government investment in major industrial sectors and the support of startups, is aimed at turning China into an international powerhouse in such industries as automotive, aerospace, and railcar production. The program wants to mirror the success China has seen with its solar panel industry—where it has become the No. 1 producer internationally—and in its civilian drone production, which in less than a decade has come to dominate the marketplace. Dajiang Innovation Technology Co. (DJI), based in Shenzhen—the Chinese equivalent of Santa Clara, California—holds a 74 percent global market share.

CHINA HAS SEEN A DRAMATIC RISE IN PATENT GRANTS AND R&D INVESTMENT

Total patent grants
2000-2017, In thousands¹



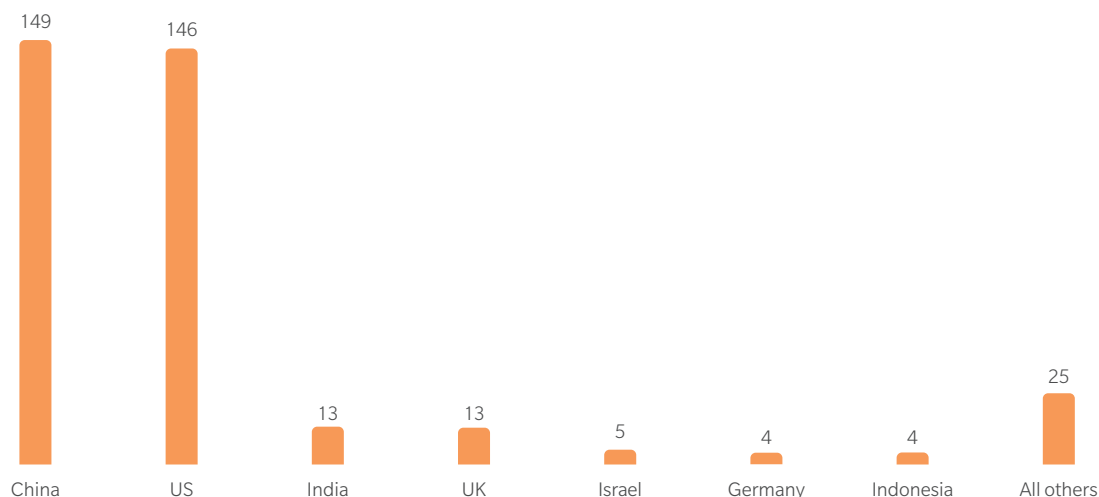
Gross domestic R&D expenditure
2000-2016, In billions of current purchasing power parity dollars



1. Direct and patent cooperation treaty national phase entries by applicant's origin (equivalent count)

Source: WIPO, Oliver Wyman analyses

THE GLOBAL COUNT OF UNICORNS, PRIVATELY HELD COMPANIES VALUED AT \$1 BILLION OR MORE



Source: **Crunchbase News**

EV leader

So far, the most progress has been made in the automotive industry where Chinese government subsidies have helped build the largest market for electric vehicles in the world. By 2020, domestic manufacturers will have the capacity to produce 20 million EVs, reflecting the enthusiasm with which entrepreneurs are greeting the challenge. The Chinese government recently put a halt on the creation of new car manufacturing startups because of this overcapacity.

At this point, the nation hasn't started exporting EVs to the US or Europe. Even so, Chinese automakers may be better positioned than other nations to capitalize on expanding global sales. Data from the International Energy Agency show the rapid acceleration in sales of EVs: While it took about 10 years to sell the first million EVs, it took less than a year to boost sales from three million to four million and then to five million a few months after that.

For certain, China has been helped by its massive population and one of the fastest-growing middle classes in the world. This provides companies a ready-made domestic market that can support innovation and sustain high levels of production without selling overseas. The sizable domestic market allows Chinese producers to become economically viable before taking on the world market.

Entrepreneurial population

China also boasts a population that is highly entrepreneurial and hungry for new technology. One of

the reasons for the rapid growth in Chinese ride-hailing can be attributed to the number of Chinese who seek to supplement their income by driving.

Chinese consumers also show a willingness to try new technologies. In a [2018 survey on mobility conducted by Oliver Wyman](#), 33 percent of Chinese respondents said they were "very likely" to switch from public transport to autonomous vehicles when they became available; 50 percent said they were "likely" to switch. That compares with only 13 percent of US respondents and 12 percent of German respondents who said they were "very likely" to switch.

For the US and Europe, the transformation of China into an innovation powerhouse means they too must increase their commitments to R&D and create favorable economic environments for collaborative innovation if they want to compete. This may mean speeding product development cycles or encouraging more joint ventures. But one thing is for sure, especially when it comes to mobility—China is moving quickly.

Heiko Rauscher

is a partner in Oliver Wyman's automotive practice. He's now based in Oliver Wyman's Munich offices after working more than 10 years as a consultant in China.

This article first appeared in [MIT Sloan Management Review](#) on June 10, 2019.

FROM TOY TO TRANSPORT

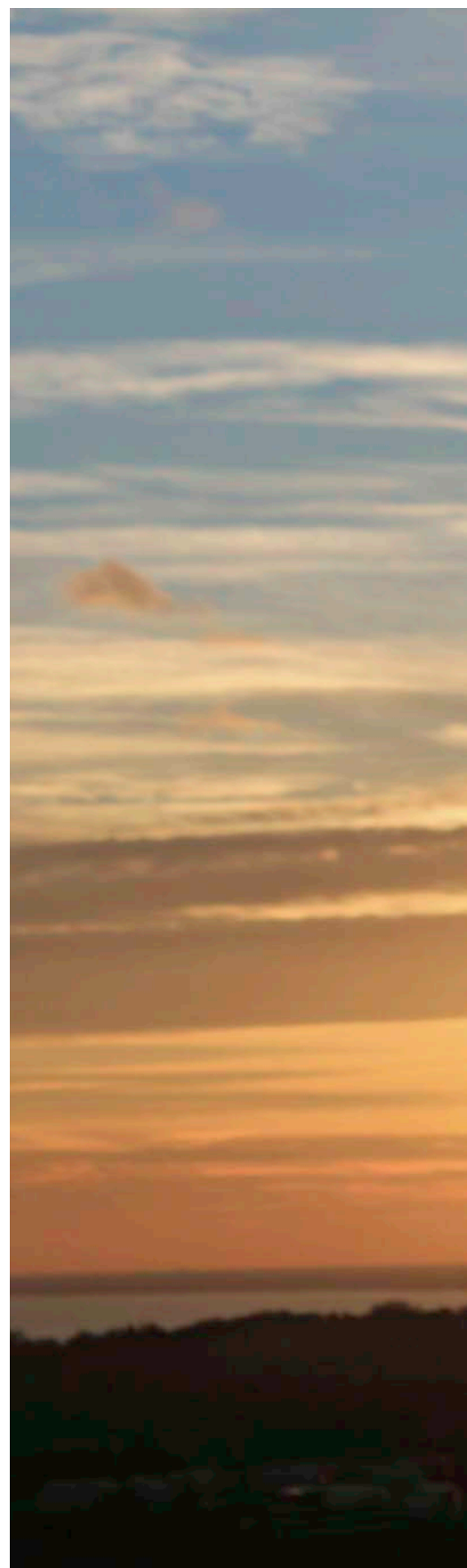
Delivery drones must prove their airworthiness before operating too close to the public

Anthony DiNota • Steve Douglas • Dave Marcontell

THE DRONE DELIVERY industry took a step forward at the beginning of October, but it remains several steps away from a commercial-scale enterprise. While the Federal Aviation Administration (FAA) granted UPS air carrier certification with fewer restrictions than it granted Alphabet's Project Wing in April, the parcel delivery giant will still be limited essentially to rural areas and hospital campuses for the foreseeable future.

This is not to downplay the significance of the FAA approvals. They mark a new receptivity on the part of the agency to drone delivery in the United States and progress that suggests the world may see full-scale commercial delivery drones in perhaps a couple of years.

But the Part 135 certification that grants air carrier status only gets companies partway down the road. Like all innovations that pose a risk to life and property, drone technology has several problems to solve before it can be incorporated into the global economy and airspace of nations around the world. First and foremost, whether moving people or things, the drone equipment will need to prove itself airworthy—that is, safe for flight—and be able to demonstrate long-term reliability before getting "Type Certified" by the FAA and national airworthiness regulators in other countries. This represents the second and final step before large-scale commercial operations can commence.





It's likely cities will see delivery drones in the next few years after a few technology challenges are met

Reliability guarantees

Ahead of drones being permitted to fly over populated areas or pose any kind of risk to the public or infrastructure, operators must demonstrate to regulators reliability performance similar to that required for commercial aircraft. In commercial aviation, a critical system failure is tolerated only once in one billion hours of flight, a very high bar. Even sophisticated unmanned aerial vehicles (UAVs) don't come close to that number—in fact, they are several orders of magnitude below it.

Until now, drone technology—comprised mostly of what has been developed for the consumer market rather than commercial and industrial use—has not been held to the highest standard of reliability. Hobby drones often fail in a matter of months of occasional use, a standard that regulators will not accept—especially as drones get bigger. In its testing program, Project Wing has been using an 11-pound drone that can carry about three pounds of cargo, perfect for some food or pharmaceutical deliveries. Delivery drones that size represent marginal risk to the public if systems fail and are unlikely to be required to reach the highest airworthiness standards. UPS has now been technically

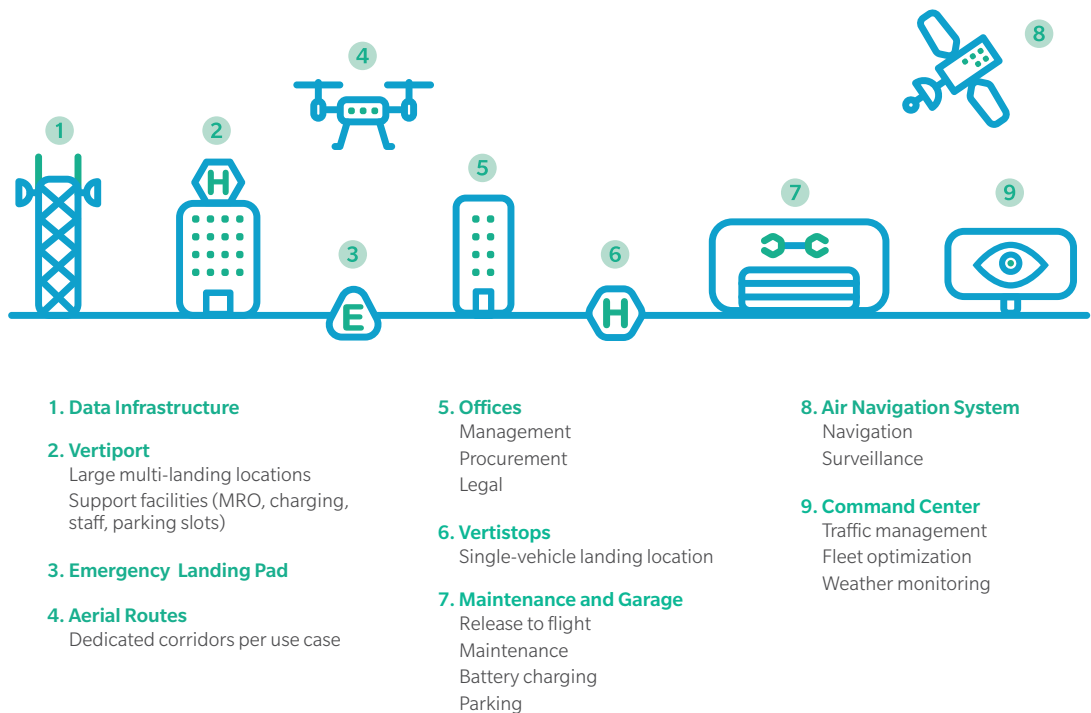
granted permission to fly drones over 55 pounds. As drones increase in size, they pose greater risk and reliability must be higher than for a hobby drone.

And what about when companies want to operate drones designed to move packages in bulk or transport heavy equipment? These larger drones, as well as flying taxis carrying people, will need to be similar in size to today's military drones, which can weigh almost 5,000 pounds. That means aspirational drone manufacturers and their operator customers must get their equipment type-certified as airworthy, the same way that aerospace manufacturers like Boeing and Airbus do. And airworthiness for larger commercial drones will be set at orders of magnitude higher than demonstrated drone reliability today, although perhaps less than the once in a billion flight hours reliability required of a commercial airliner.

A drone's eyes

That's a challenge made even more difficult by the fact that no certification standards currently exist for UAVs. Fundamental technology hurdles also must be scaled

THE INFRASTRUCTURE DRONES NEED TO GO COMMERCIAL



Source: **Oliver Wyman** analysis

before UAVs can achieve airworthiness. Probably the biggest and most essential criterion, when it comes to operating in the National Airspace System, is the ability to detect and avoid colliding with other things, fixed or flying.

With a drone, there's no human pilot to watch out for electrical wires, birds, buildings, helicopters, or low-flying planes. That's why most regulation requires drones to stay in the line of sight of the operator—a restriction that makes a commercial-scale drone business economically unviable.

Some progress has been made in the last two years. Amazon, which has been pursuing drone delivery since 2013, has received patents for an autonomous air traffic control system. Amazon's technology would essentially create a flight management system that relies on sensors and wireless communication to alert drones about other drones operating in the same airspace and let them adjust their flight paths to avoid collisions. The system would be the drone version of the Traffic Alert and Collision Avoidance Systems that commercial transport aircraft are required to have in regulated airspace.

The FAA, National Aeronautics and Space Administration, and private industry are also collaborating on their own versions of an air traffic control system for drones in unregulated, low-altitude airspace. Either way, without technology like this, it would be hard to see how drone delivery companies could operate anywhere but remote, sparsely populated areas.

Off the ground

Despite the obstacles, delivery drones are already operating and proving to be huge logistical problem-solvers—although not so much in the US or in densely populated areas. In Rwanda and Ghana, Zipline runs the world's largest delivery drone network, carrying vaccines, medications, and blood to rural hospitals. In Iceland, a Reykjavik-based food delivery service uses drones to cut the time to get orders to customers, especially in places difficult to reach by car because of the nation's coastal inlets and winding roads. And in April, a drone delivered a donated kidney for a transplant patient in Maryland, showing how the technology might be used in medical emergencies or in situations like with donated organs when speed is required. That said, it was a 2.8-mile test flight that took less than 10 minutes and was limited to the University of Maryland campus.

UPS is also planning to build its initial business around medical facilities and the need to move equipment and life-saving medicines to their destinations quickly. After it was granted its Part 135 approval, UPS made its first run for a paying customer—WakeMed Health and Hospital near Raleigh, North Carolina. The flight was out of the

Drones are already proving to be huge logistical problem-solvers in less populated areas

line of sight of the drone operator, another necessary condition if drones are to create an economically viable service.

Slowly but consistently, delivery drones are being incorporated into the global logistics and distribution network. As drones prove their usefulness, it is hoped the public will grow more accepting of seeing them in low-level airspace and hearing their signature buzz, like a swarm of bees for smaller models.

Of course, it takes only one or two tragic accidents for the public to withdraw its approval—just look at the plight of urban helicopter transport after a couple of high-profile crashes. That's why, in more densely populated areas and more heavily regulated airspace, commercial-scale drone delivery must wait until the equivalent of airworthiness standards are adopted and the technology to achieve them is demonstrated.

Anthony DiNota

is a Fort Worth, Texas-based vice president at Oliver Wyman CAVOK and a former helicopter company executive who has worked extensively on safety issues.

Steve Douglas

is a Fort Worth, Texas-based vice president at Oliver Wyman CAVOK and a former senior executive with the Federal Aviation Administration, where he coordinated the agency's rulemaking and the determination of exemptions and deviations.

Dave Marcontell

is an Atlanta-based senior vice president and general manager of Oliver Wyman CAVOK and a former FAA-Designated Engineering Representative and experienced air carrier certification expert.

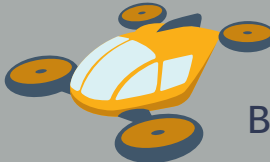
This article first appeared in [Forbes](#) on October 7, 2019.

NEW MOBILITY BY THE NUMBERS

The mobility industry is undergoing a seismic transformation, driven by a host of new technologies from artificial intelligence and automation to the electrification of transportation and the Internet of Things.

The market for electric vertical takeoff and landing aircraft (eVTOL) IS EXPECTED TO HIT

\$35
BILLION BY 2035



75%

OF PASSENGER
RAIL IS ELECTRIFIED GLOBALLY

It is the only transport sector that is widely electrified

IN 2037

ELECTRIC CAR
SALES WILL
SURPASS INTERNAL
COMBUSTION CARS



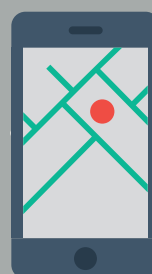
SELF-DRIVING CARS
COULD REDUCE
ACCIDENTS BY UP TO

90%



36%

OF PEOPLE IN
THE US USE
RIDE-HAILING APPS





95%

**OF A CAR'S LIFE
IS PARKED**

Shared vehicles may
reduce this idle time

**MOBILITY
IS EXPANDING**

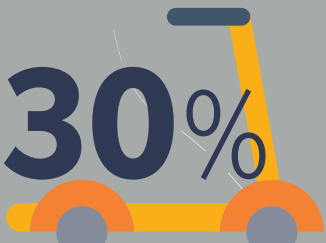
30%

**FASTER THAN THE GLOBAL
GROSS DOMESTIC PRODUCT**



\$14.9 TN
in 2017

\$26.6 TN
in 2030

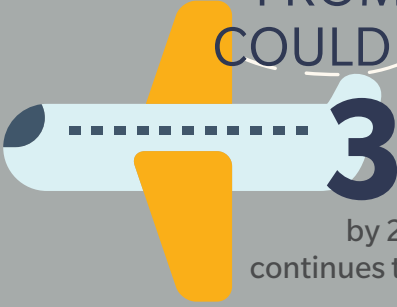


30%

OF E-SCOOTER USERS

said they replaced a trip
by automobile with an
e-scooter ride

**EMISSIONS
FROM AVIATION
COULD INCREASE**



300%

by 2050 if the industry
continues to rely on fossil fuel



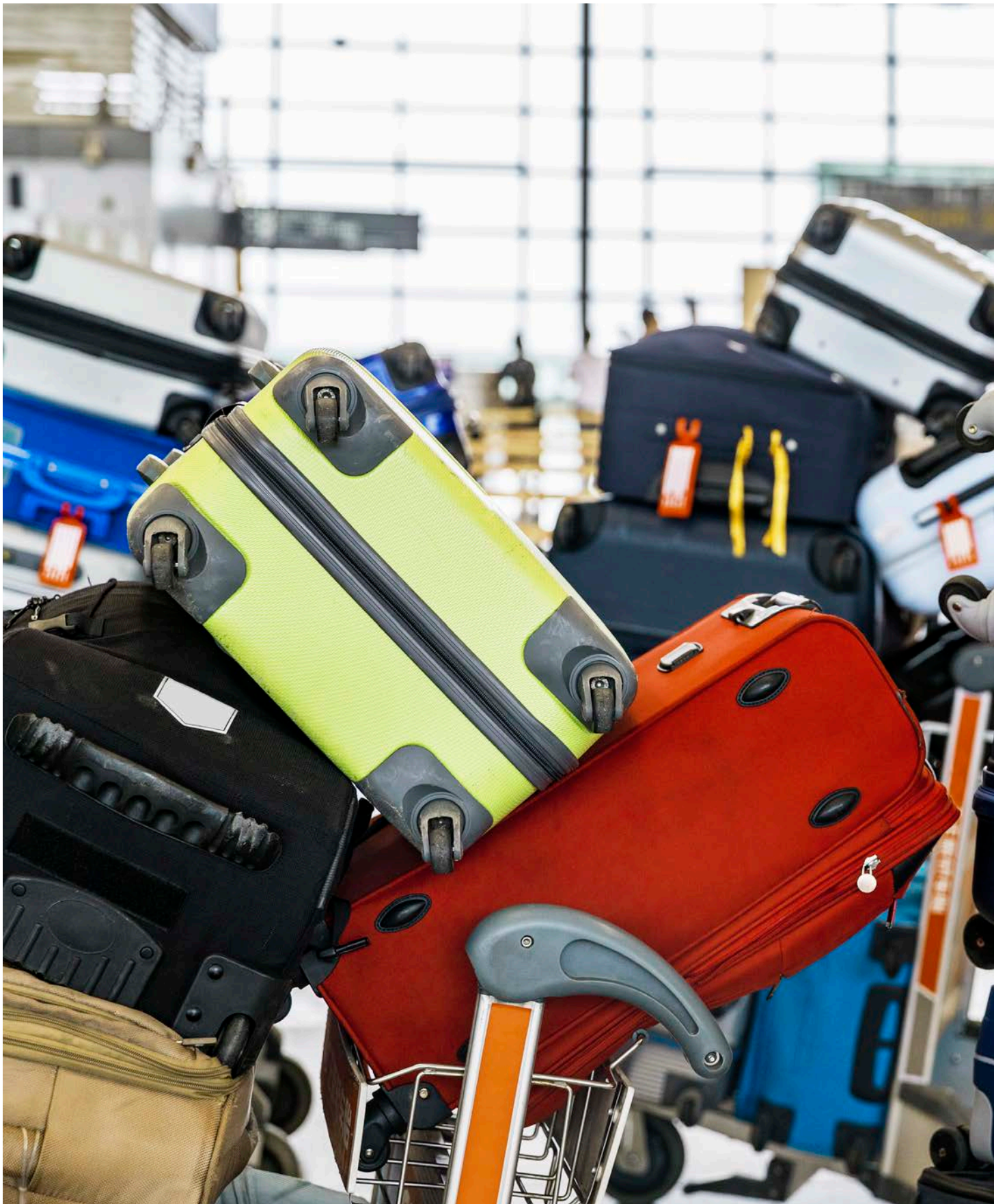
IN 2018

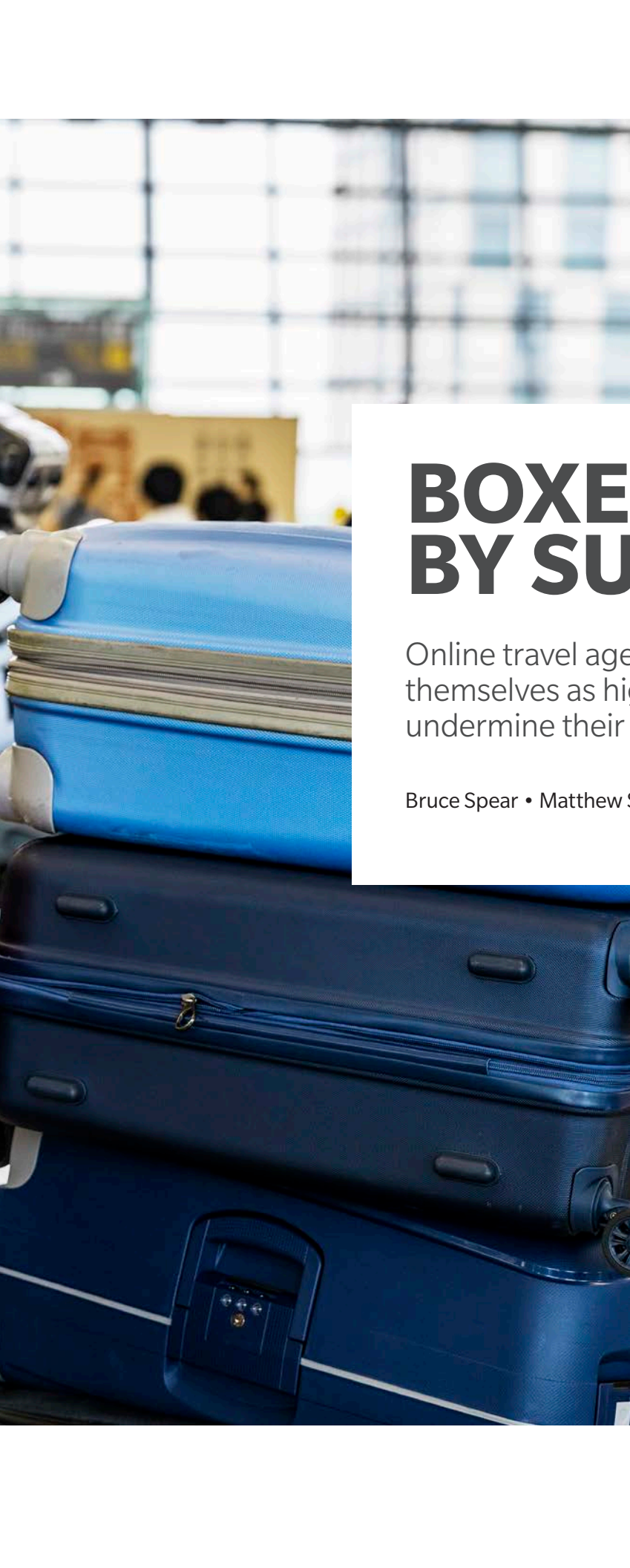
45%

**OF ELECTRIC CARS ON THE ROAD
WORLDWIDE WERE IN CHINA**

By 2030 half of the cars on the road in
China are expected to be EVs

Source: Oliver Wyman analysis





The smart use of online search to aggregate travel data is no longer the sole province of the big OTAs

BOXED IN BY SUCCESS

Online travel agencies need to reinvent themselves as higher costs and a new rival undermine their business model

Bruce Spear • Matthew Schabas

ONLINE TRAVEL AGENCIES (OTAs) are the original digital disruptors—first-generation internet businesses that identified an unmet customer need and created digital destinations that became the first stop for prospective travelers. Yet the very thing that gave rise to OTAs—the ability to aggregate digitized data to create economical, do-it-yourself travel planning—now threatens to be their undoing. As with most erstwhile digital upstarts and once-transformative business models, OTAs must disrupt again or risk being disrupted.

Where 20 years ago planning travel was a complicated, anxiety-fraught exercise, travelers today feel more in control, thanks in large part to OTAs. The digitalized travel model brought comparison shopping and price transparency to desktops and mobile devices, and travelers embraced this self-sufficient approach to planning business and pleasure trips because of its enhanced flexibility and customization.

That awakening helped produce explosive growth for both travel and OTAs but spawned myriad challengers competing for the same customer. Eventually, the explosion of rivals led to bigger and savvier OTAs as small ones were gobbled up.

New rivalries

The consolidation created heavyweights in the travel value chain. Booking Holdings and Expedia, the two biggest OTAs, boast a combined market cap of more than \$100 billion, comparable to the four largest US airlines combined.

But competition doesn't end there. The biggest threat in travel planning could eventually come from the tech powerhouse that helped OTAs become successful in the first place. After years of quietly building a brand in travel, Google today has become a leading option for travel search, second only to Expedia.

While Google still sends most customers to its advertisers to book, the tech giant has introduced close to one-stop shopping over desktop and mobile app; it also can complete the booking for some hotels and flights. In time, it will extend the tool to Google Assistant. But what gives Google its edge in travel are the petabytes of data at its disposal from its purchases of ITA Software for flights and Zagat for restaurants, building up its hotel metasearch comparisons, and the trillions of travel searches going on daily via Google.

Costs and commissions

But Google isn't the only thorn in the OTAs' side. Besides rising competition, OTAs are also seeing their operating costs climb and the once prescient business model undermined. The culprit: The cost of search engine marketing (SEM)—the most important tool in the OTA toolkit—has been increasing. Booking.com alone spent

over \$4.4 billion in 2018 on performance marketing, which is essentially SEM. Booking's expense represents about three percent of Google's advertising revenue. So not only is Google pocketing Booking's money, it is also grabbing new travel data with each click.

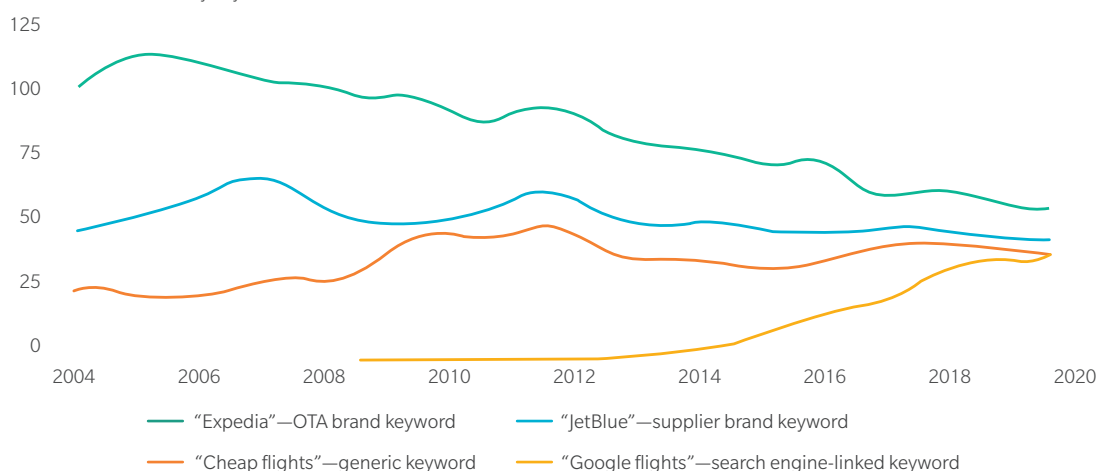
Here's how SEM works: Through Google AdWords or Bing Ads, companies bid on high-value keywords and phrases such as "flights to Spain" or "New York hotel" that indicate an intent to travel. The bidder—in this case, the OTA—only pays the search provider if a customer clicks on its link. OTAs make money by converting those click-throughs into purchases of flights, hotel rooms, rail tickets, or rental cars. OTA profitability depends on keeping the cost-per-click lower than the revenue on a customer transaction, multiplied by the rate at which the OTA is able to convert visitors into purchasers.

If a consumer visits multiple sites or even the same OTA multiple times from different platforms without making a purchase, the OTA loses money—a practice that is becoming common, as would-be travelers increasingly comparison-shop. (See *"The Super Informed Traveler,"* on page 44) Even when consumers do complete a purchase, OTAs struggle with how to credit the sale, given the array of click-throughs and impressions associated with it. That raises the risk of overpaying for SEM.

Travel SEM is not limited to OTAs. Among the regulars competing for travel keywords: airlines, hotel chains, rental car agencies, passenger rail companies, and cruise lines. This creates a bidding war for the best keywords.

TRAVELERS' SEARCH ENGINE PATTERNS ARE CHANGING

US air travel searches by keyword



Notes: 12-month trailing averages. Indexed to Expedia search volume, January 2004 = 100

Source: Google Trends, Oliver Wyman analysis

Disruptor headaches

OTAs and others in the travel industry are not the only ones facing rising SEM costs, overcrowded marketplaces, and disruption by a new wave of innovators and big corporate names. The same scenario has been playing out in sectors including real estate, autos and insurance that have also been digitally disrupted by savvy SEM. Upstarts like Zillow began upending traditional real estate over a decade ago, and the shakeup and SEM frenzy have continued with News Corp.'s purchase of Realtor.com in 2014 and the creation of online sites like Streeteasy, which specializes in big city real estate.

For OTAs, the pressure comes from more than higher costs. OTAs' primary source of revenue—commissions paid by travel providers—is threatened by industry consolidation and providers' push to promote direct booking. Airlines, which have been consolidating for more than a decade, are using apps and loyalty programs to encourage customers to book directly with them. Because airlines rely less on OTAs, they pay significantly lower commissions. The new OTA economics can mean that net of the SEM costs, an OTA may lose money on the sale of a flight.

While hospitality and cruises have offered OTAs an opportunity to earn higher margins than on air travel, consolidation and competition here too are starting to cause problems for OTAs. Large hotel chains are determined to get their distribution costs down by negotiating lower OTA commissions and pushing their own direct channels. To accomplish this, most reserve their best deals and properties for their own channels and OTAs willing to play ball on commissions. OTA hotel offerings are also suffering because of competition from alternative lodging platforms like Airbnb that don't make their offerings available through OTAs.

Fork in the road

OTAs do have options to grow and better compete. One would be to fine-tune their use of paid search. Developing the capabilities to integrate search activity, site activity, and customer relationship management data could help OTAs identify keywords associated with the most attractive customer segments—those that generate higher margin per transaction—and keep ahead of rising SEM costs.

Another option would be to become one-stop shops, like the travel agents of yesteryear but adapted to an online, data-driven environment. OTAs have the reach and capabilities to provide full-service vacation planning, including tours, attractions, classes, and theater tickets, which would offer more margin opportunity and appeal to a new generation of upscale travelers. Surprisingly, travel agents are enjoying a mini-resurgence with millennials, who want curated, personalized travel

The biggest threat to OTAs comes from Google, the tech powerhouse that was key to their success

planning, according to the 2019 Portrait of American Travelers survey, conducted by travel agency MMGY Global. The survey suggests that not doing everything online and providing person-to-person expertise might lead to more customer loyalty. Creating call centers and a local presence, once eschewed by OTAs, could be differentiators.

A third route is to rethink the marketing mix and reduce reliance on SEM. Some OTAs are looking at traditional media, such as television, radio, and outdoor advertising, as a more cost-effective way to reach buyers. The goal would be to get customers to bypass search engines and go directly to an OTA-branded website or app.

Finally, OTAs could change how they interact with customers. Instead of simply taking orders and delivering the goods, they could become travel advisers, telling travelers about what they haven't considered, but may very well enjoy. Such inspirational power is well within the capabilities of today's artificial intelligence and visual rendering technologies. And it just may be the new identity that could help OTAs disrupt the status quo again with a 21st century business model built to satisfy a much savvier traveler.

Bruce Spear

is a New York-based partner in Oliver Wyman's transportation and services practice and the pricing, sales, and marketing practice.

Matthew Schabas

is a New York-based associate in Oliver Wyman's transportation and services practice.

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THE FUTURE IS BIOMETRIC

In the not-too-distant future, travelers may use facial recognition instead of passports and boarding passes

Alex Hill • Helena Bononi

WHEN PEOPLE WANT to travel somewhere by air today, one physical thing they must have is a piece of identification. If they're traveling domestically in the United States, they need a driver's license or some form of officially acceptable photo ID. Internationally, they need a passport. They also need a boarding pass.

But what if they didn't? What if they could simply depend on their face, eyes, or thumb print to get them on an airplane? Traveling

would be easier and a lot safer. Where a passport or driver's license can be forged, it's very difficult to fool biometric technology, such as facial recognition, retinal scans, and fingerprints.

That's the travel industry's vision of the future—a system that replaces current documentation with verified biometrics. This would involve more than simply substituting biometrics for a passport or boarding pass. Eventually, the goal would be for travelers to

use biometrics to replace the need for air or rail tickets or an official ID to check into a hotel, rent a car, or board a cruise ship. Biometrics would essentially serve as a traveler's identification and documentation through all stages of a journey.

A look into the future

While it may sound futuristic, it's already beginning to happen at a few of the world's most congested airports where high volume is prompting a search for more efficiencies. In the US, for instance, airlines at John F. Kennedy International are being allowed to leverage highly advanced facial recognition technology used by the US Customs and Border Protection (CBP) to expedite passenger check-in, baggage drop, and boarding. The nation's first curb-to-gate biometric terminal was opened last year by Atlanta's Hartsfield Jackson International Airport and Delta Air Lines that relies on optional facial recognition from check-in to baggage claim.

Sophisticated encryption systems are being developed to protect against a hack of biometric data

Until recently, biometrics have been a tool used by nations to keep terrorists and other undesirables out. For example, the US has one of the most advanced systems of facial recognition that analyzes more than 100 points of reference on each face to evaluate whether people are who they say they are. Its Traveler Verification Service has become the aspirational standard for dozens of other countries looking to employ biometrics to screen people crossing their borders.

While groups like the International Air Transport Association (IATA) see biometrics as a tool to improve the flow of people through airports and across borders, the broader travel industry—through organizations like the World Travel and Tourism Council (WTTC)—wants to work towards the integration of biometrics, particularly facial recognition, across the entire travel

experience. That would mean from booking, to arrival, to check in, to departure—whether it's picking up a car, getting a hotel room, or boarding a plane, train or boat. It's an innovation that the industry expects would likely encourage more people to travel, while avoiding a significant increase in resources necessary to accommodate the growth. But it would also make more efficient a system that currently emphasizes security over ease of travel.

Enhanced encryption

As it stands, the travel experience constantly requires people to flash travel documents at airports, hotels, and rental car agencies, and when boarding trains, planes, cruise ships, or buses. The travel industry is investigating whether this information could be instead stored on a traveler's mobile phone. With this approach, the travelers would be free to share their biometric markers with whichever travel entities they choose and would no longer need worry about forgetting or losing IDs and tickets or getting them stolen.

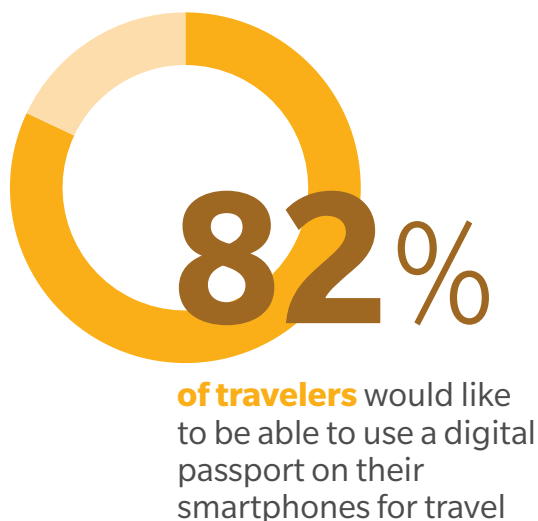
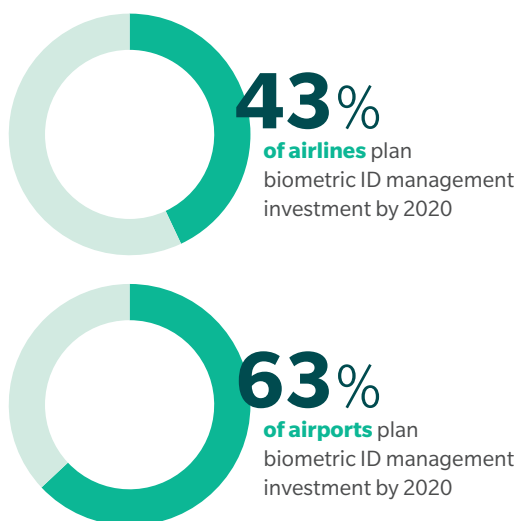
Of course, there would be the challenge of how to keep information safe and limit access to authorized users, while enabling interoperability across a wide range of travel providers. In response, increasingly sophisticated encryption systems are being developed to protect against a hack of biometric data.

In addition to enhanced security, the evolving encrypted tools can act as a repository for customer travel preferences, encouraging more customization of travel offerings. They can also provide alerts when travelers have been delayed. For instance, delays at the airport could be filtered through the entire system, giving advance notice to hotels and rental car agencies. This becomes a plus for service providers as well, allowing them to redeploy resources to accommodate the delay or ensure a hotel room or car rental is ready when needed.

Outside of airports

From the perspective of travel businesses operating outside of the airport environment's advanced security, digital identity verification becomes an enhanced safety net. Up until now, rental car agencies, hotels, trains, buses, and cruise ships have had to provide their own verification. How, for instance, can a rental car agency know for a fact a license being presented at a counter is valid without relying on manual verification?

For cruise lines, the stakes are even higher because they are transporting thousands of people, often across national borders. Adopting a system akin to sophisticated airport surveillance and authentication would be particularly valuable when thousands are looking to board or disembark.



Source: 2017 Survey by International Air Transport Association; Sita Surveys, 2017

Yet, fears around data privacy and safety are prompting officials and executives to move cautiously when it comes to an expansion of biometric identification, despite the availability of the technology. The Transportation Security Administration recently announced that it would not make biometric identity verification mandatory, even though the agency has developed pilots to help make the technology more efficient. The decision may be connected to the theft of almost 100,000 photos of travelers and license plates collected by Customs and Border Protection and stored on an outside contractor's database, according to the agency.

Public versus private

There are various models of how digital identity services might evolve—some that envision a government-controlled or government-driven model and others based on a private subscription model. Regardless, every model will have to recognize that travelers will not be equally willing to share personal information and provide them the ability to deny access.

The WTTC has identified as many as 53 efforts to implement biometrics in six regions around the world. Currently, deployed systems primarily exist in airports in the US, the European Union, Southeast Asia, and the Caribbean to facilitate border control, with a select few of those in pilots that enable processing of bags, lounge access, and boarding. Meanwhile, several travel providers are planning trials to test whether versions of existing systems could be expanded to integrate travel businesses outside of airports as well, with a goal of

solidifying the business case for end-to-end seamless travel and jump-starting global adoption.

For the foreseeable future, no consensus exists around a one-size-fits-all solution, but the travel industry is pushing for collaboration across national boundaries and between private companies and governments to try to reduce the number of iterations travelers will have to deal with moving forward. The good news: Travelers are already beginning to see sneak peeks of what the benefits of seamless travel through biometrics might be like, and as they become more comfortable with it, so too may authorities.

Alex Hill

is a Chicago-based principal in Oliver Wyman's transportation and services practice and pricing, sales and marketing practice.

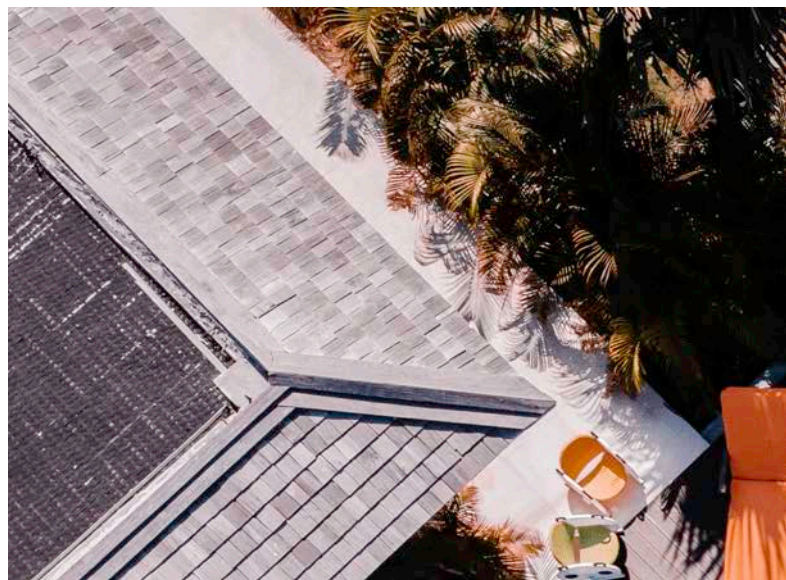
Helena Bononi

is vice president of industry affairs for the World Travel & Tourism Council.

Mike Matheis and Scot Hornick,

both Oliver Wyman partners, contributed insights and research to this article.

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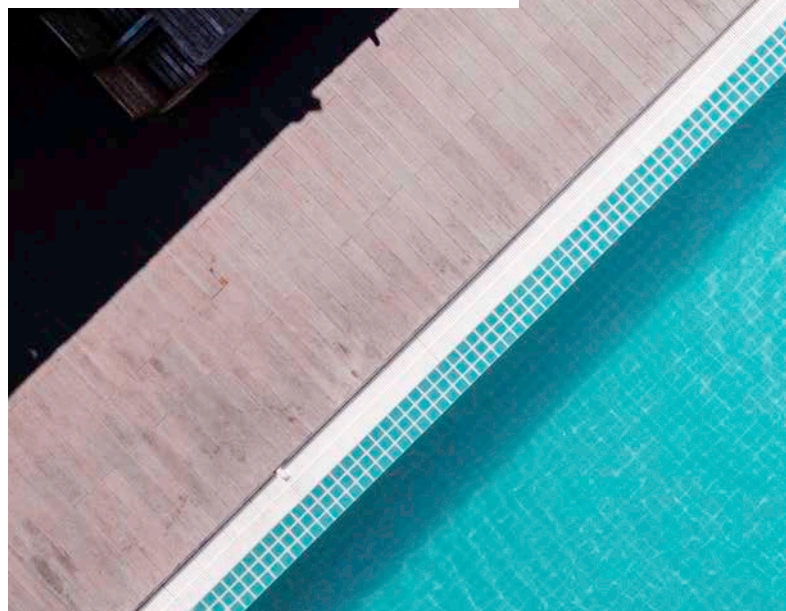
HAPPY CUSTOMER, HEALTHY COMPANY

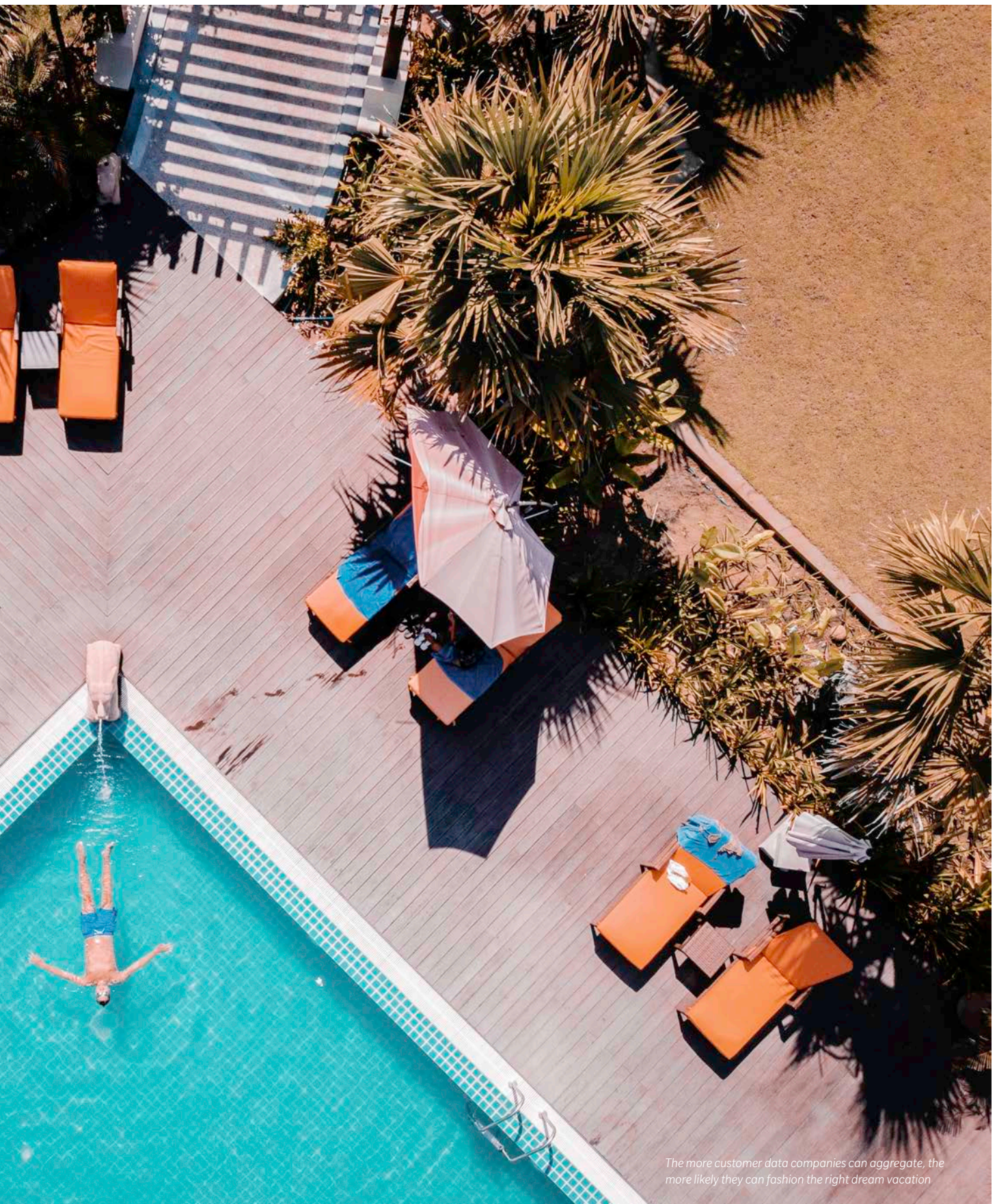
How to make the (gold) rush to personalize travel experiences profitable for travel companies

Scot Hornick • Jessica Stansbury • Jatin Goradia • Alex Hill

TRAVEL COMPANIES WANT to provide a personalized experience for customers, but they're coming up short. The problem is not a lack of data: They're collecting plenty through apps, websites, loyalty programs, and more. Every time families or businesspeople travel, they leave a digital trail about what they look for in a hotel, airline, rental car agency, cruise ship, or rail provider. Do they prefer a high floor or a room with a view? Do they like aisle or window seats, or early morning or early evening departures and arrivals? Do they go for an SUV or the intermediate sedan? Over the past five years, travel providers have been accumulating petabytes of data on their most loyal customers.

Despite this treasure trove, many companies still use just the contact information to send offers they're eager to sell rather than what the customer wants. If a traveler heads to the Chicago Jazz Festival at the end of each summer or skis in Aspen every winter, that potential customer should receive hospitality offers





The more customer data companies can aggregate, the more likely they can fashion the right dream vacation

months earlier that make those bookings easier, less expensive, or more enjoyable. Instead, these travelers may get pitches about overpriced flights to Europe in the summer or to the Caribbean in the winter. Even if travel providers get a customer's first name right or offer packages that match a family's usual selections, they may miss the target on deals that interest their shoppers at that moment.

Why does that happen? Because customers are still hearing about the products that one or two departments at a travel company want to sell most. Rarely do members of digital, customer relationship management, loyalty programs, distribution channels, and revenue management operations sit down together to define the metrics and rules to best match commercial priorities to customer needs and preferences.

This is further exacerbated by inefficient processes that limit quick turnaround of omnichannel-targeted campaigns driven by dynamic commercial conditions. In the end, the efforts toward personalization are leaving both sides unfulfilled—customers aren't being offered what they want, and travel providers fear they're leaving money on the table.

Breaking down silos

Part of the problem stems from the walls that separate various departments at travel companies. There's just not enough data-sharing and cross-pollination among

the commercial functions to anticipate customer needs and optimize commercial decisions. And given the advances in technology today, there are fewer excuses for why that persists.

For instance, advances in big data and artificial intelligence are making it possible for travel companies to do a much better job of generating and sending personalized offers that are both relevant to each customer and profitable for the provider. This may mean targeting a micro-segment of potential customers rather than, say, all loyalty program members or all people who traveled within the last month.

To create the right target groups and deals, travel companies must leverage the various pieces of customer and non-customer data from their loyalty programs, transaction and search histories, revenue management, and websites—all of which are often stored in different places to support different functions. This is true even for efforts only aimed at a small group of customers.

Once data is shared across silos, multidisciplinary teams should analyze the information with the common goal of creating a better customer experience while maximizing profit. Then those teams must determine which customizations best fit that goal as well as how and to which customers the offers should be made. With this kind of collaboration, it becomes easier to determine how to use loyalty bonuses or promotions to steer customers toward preferred channels or optimize the price spread between different hotel rooms or airfares.

DATA THAT CAN HELP TRAVEL COMPANIES PAINT A PICTURE OF CUSTOMERS

Types of data collected

PERSONAL PROFILE

Name, title, gender, date of birth, contact details, passport information and other forms of identification, payment details

WEBSITE AND MOBILE APPS

Details on how the customer uses the site or app, frequency of use, time of use, customer's geo-locations, use of price-comparison engine, searches, queries made, third-party sites accessed from website or app, engagement and sentiment on social media

INCIDENTS

Details of any incidents involving the customer or that the customer witnesses

TRAVEL DETAILS AND PREFERENCES

Travel itineraries, checked baggage, seat preferences, meal requests, dietary requirements, requests for special assistance, use of inflight entertainment systems, purchases made during flight, travel destinations, inflight shopping

WIRELESS USAGE

Information collected about customer, customer's devices, and usage based on accessing Wi-Fi in airport lounges and onboard the aircraft

CUSTOMER INTERACTIONS

Feedback, complaints, compliments, market survey responses, claims made for such things as lost luggage, correspondence, interactions in person, by phone, through the website or on social media, penalties paid or accommodations provided in connection with cancellations or delays

Source: **Oliver Wyman analysis**

Picking the right channel

One example: Customers who book through direct channels might earn loyalty bonus points, but has the loyalty program considered the actual distribution channel costs in optimizing these offers? Often not, because the channel cost data are generated by another department. This can lead to bonuses that are too large to be profitable or too small to be effective.

On the other hand, the realities of revenue management sometimes suggest that scarce inventories of highly sought-after products, such as preferred seats on a flight or hotel rooms with specific attributes, should be offered only through the most cost-effective distribution channels—typically direct channels. Yet too often, channel management functions at travel companies don't receive revenue management's inputs soon enough—or ever—so they can curtail the offer of prized bookings through third parties.

What this suggests is a reorganization around not only the customer experience, but also around the expertise each department brings in establishing offers that are a win-win for customer and company. For that reason, we recommend creating cross-company multidisciplinary teams that include loyalty, customer relations management, revenue management, distribution, and digital for each transaction touchpoint with the customer.

Designing offers that fit customers extends beyond arriving at the right price. Travelers want the power to customize their journeys—pick their own seats, know exactly which room they're getting and the amenities that come with it, or reserve a specific model of car with a sunroof or of a certain color. And, for the first time, updates to core technology systems, such as reservations and digital platforms, are making it possible for travel companies to deliver on a more customized experience.

Next, better analytics

For this to be successful, travel companies must put a priority on building a database that consolidates information from websites, platforms, mobile apps, sales forces, on-the-ground operations, revenue management functions, and customer relationship management and reservation systems. This is a must-have—and one in which most large travel providers have invested over the past few years. This common fact-based foundation enables collaboration that will better meet customer needs at the optimal price point.

On top of that, companies must develop or acquire advanced analytics capabilities that fully exploit these vast data resources to create personalized, relevant deals for customers, while also coordinating these

Big data and artificial intelligence are generating personalized offers that are relevant and profitable

capabilities with their revenue management decisions and marketing efforts. This will require an elevation of the workforce to include data engineering and artificial intelligence personnel, especially those with machine learning expertise.

Finally, management needs to reflect a world that is much less static. Where once deep expertise and specialization were the chief requirements, travel executives today must be agile, collaborative, and able to understand and work across multiple commercial disciplines. Recognized leaders in this area are already reaping the benefits by significantly increasing revenue and ancillary sales.

More than ever, travel companies have the tools for success. But it will require dropping vestiges of past organizational structures and mindsets to realize their full potential.

Scot Hornick

is a Dallas-based partner in Oliver Wyman's transportation and services practice and the pricing, sales, and marketing practice.

Jessica Stansbury

is a Washington, DC-based partner in Oliver Wyman's pricing, sales, and marketing practice and the transportation and services practice.

Jatin Goradia

is a New York-based partner in the digital practice and the transportation and services practice at Oliver Wyman.

Alex Hill

is a Chicago-based principal in Oliver Wyman's transportation and services practice and pricing, sales, and marketing practice.

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Today consumers have 24/7
access to travel information



THE SUPER INFORMED TRAVELER

With smartphones, apps, websites, and loyalty programs showing what's possible, today's traveler is more difficult than ever to please

Marianne Connault • Bruno Despujol • Simon Glynn

THE 21ST CENTURY traveler is a different animal than the one moving around the planet only a quarter century ago. Imagine telling someone in 1995 that vacations would be planned around staying in a stranger's apartment rather than a hotel, or that passengers would get out of cabs without handing the driver cash, or that people would ask robots for restaurant choices, flight options, and directions.

Today's consumers have more information at their fingertips, day and night, than most travel agents had in the 1990s. It shouldn't be surprising that these super-informed travelers are unwilling to put up with

20th century inefficiencies and limitations when making reservations, picking up rental cars, checking into hotels, or boarding flights. With so many options, so much flexibility, and increasingly high expectations, they're harder to please and always wondering what else a provider can offer.

Typical trip-planning for a traveler involves **50** online searches, **38** site visits, and **12** reviews

As a result, the typical traveler dives into a complex online search maze to find the best or the cheapest deals—an effort that involves, on average, 50 online searches, 38 site visits, and a dozen reviews. The overwhelming number of choices often leads to indecision, with more than 80 percent pulling out of pre-purchase bookings—a higher rate than for retail, finance, and fashion.

This super-charged yet fickle consumer is putting pressure on the travel industry to step up service and move to technology that can provide the seamless experience so often talked about for travel but only occasionally realized. Here are five attributes that make this picky consumer so demanding:

ONE

Travelers expect seamless experiences with nonstop connectivity.

Consumers today are simply not willing to disengage from the rest of their lives—even for a few minutes—unless by choice. When traveling, they depend on the internet's 24/7 stream of data to prevent scheduling hiccups, track itineraries, find destinations, make bookings, and keep the experience as frictionless as

possible. That means, at a minimum, travel modes must offer reliable connectivity that enables consumers to use their devices to do anything from anywhere. With the imminent arrival of 5G wireless and Li-Fi, which uses the light spectrum from LED lights, the demand will only get louder and more insistent.

To satisfy the quest for seamless travel, companies are creating platforms and apps that provide their customers with up-to-the-minute reports on the progress of their trip, making real-time accuracy particularly important to today's consumer. According to a 2018 study on trends in navigation apps, 70 percent of that market is based on the ability to access real-time, end-to-end information.

But what consumers want is one-stop shopping for travel. Eventually, given the competition for real estate on mobile devices, that will lead travelers to winnow down once they find an app that lets them do everything they want by swiping without searching.

TWO

Travelers want on-demand everything.

The pace of life is so much faster these days, thanks to connectivity and the internet. Travelers, and people in general, are much less willing to wait for anything. With one click, they can shop, bank, order food, pick a restaurant and make reservations, set appointments, buy tickets, communicate with friends, and be entertained. So why can't they handle travel needs with the same expediency?

When it comes to air travel, for instance, statistics show the significant role on-time performance plays in a consumer's choice of airlines. There's a 90 percent direct correlation between on-time performance and satisfaction, according to a 2018 passenger survey by the International Air Transport Association.

THREE

Travelers depend on exponential intelligence.

One of the most defining characteristics of the modern traveler is his or her comfort with technology, depending on it to plan vacations and business trips and complete transactions. Almost overnight, reliance on artificial intelligence has become a way of life for people.

And whether digital natives or not, they don't mind interacting with computers—as long as their questions are answered easily and correctly.

One clear example of the role that advanced technology plays in travel these days is the openness of consumers to synthetic realities. Travelers want a taste of what they are buying before they commit, and what better way to experience a future vacation than via virtual or augmented reality? Travel providers report consistent upticks in bookings and engagement following this kind of immersive experience.

FOUR

Travelers live a transparent existence.

Because technology is in their comfort zone, travelers are increasingly willing to share data. Even with baby boomers, who appear to be the most protective of their data, more than half are willing to share for a promise of something in return, such as a discount or advance information about sales or availability.

Travelers also are willing to share their experiences—good and bad. A 2017 report by *Jetsetter Magazine* revealed that 60 percent of travelers share experiences on social media while on a trip and a stunning 93 percent post reviews about vacations. As a result, social media is becoming more influential in decisions. Time and time again, major brands report the ability to increase revenue based on positive recommendations from users on social media.

FIVE

Travelers want you to get them.

Part of the reason travelers are so willing to share personal data is they see their trips and travel choices as reflections of who they are. That means to engage a customer, travel companies need to get to know that person. Fortunately, there are petabytes of data flowing every year into hotels, airlines, rental car agencies, cruise lines, and train operators that could offer insight. Unfortunately, many providers haven't figured out how to use these treasure troves.

For today's traveler, it's not only about making it personal, but also making it timely. Don't pester travelers several weeks before a flight about a possible upgrade deal. Studies show providers will get the best response

a few hours before the flight when the customer is thinking about it.

Expect these trends to become only more pronounced, producing a traveler who is only satisfied with an integrated, personalized, AI-assisted experience they can share on social media. And make sure not to forget a little augmented reality to help them catch an element they otherwise might miss while on the trip.

Connect daily

What does all this mean for the travel industry? It makes the job of breaking through the noise much tougher and closing transactions even harder.

In this environment, frequent interaction—defined as 20 to 30 times a month—is a necessity. Two-thirds of travel companies don't reach out nearly enough to customers, making most marketing efforts ineffective.

Loyalty programs and apps are probably the best vehicles for maintaining contact. In both cases, a customer's willingness to sign up with a provider or download an app indicates an openness to hearing from that organization. But don't leave it there. Today's traveler needs to be wooed and reminded why this company should be on speed dial.

Marianne Connault

is a Paris-based principal with Oliver Wyman's transportation and services practice and the pricing, sales, and marketing practice.

Bruno Despujol

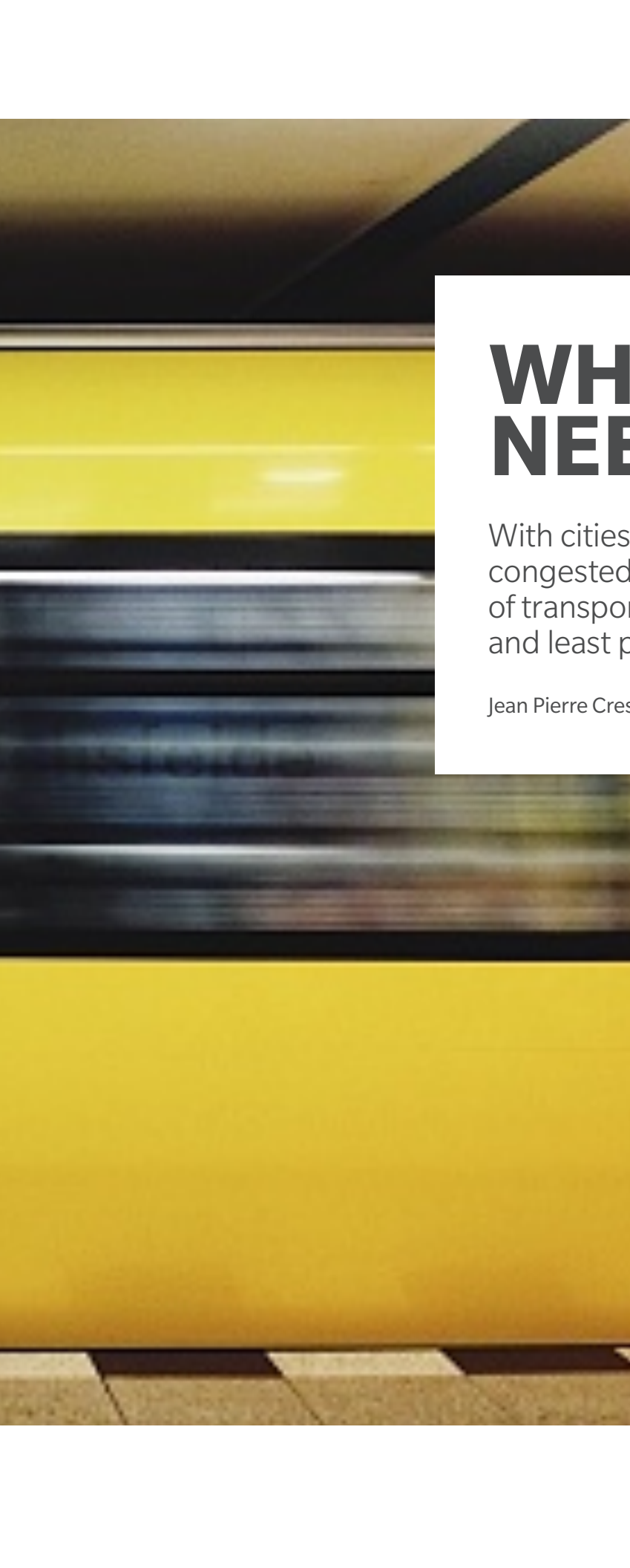
is a Paris-based partner with Oliver Wyman's transportation and services practice and the pricing, sales, and marketing practice.

Simon Glynn

is a London-based senior partner with Lippincott, a division of Oliver Wyman.

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Rail is the most efficient system for moving people around cities.

WHY CITIES NEED RAIL

With cities getting bigger and more congested, it's time to invest in the mode of transportation that's most cost-effective and least polluting

Jean Pierre Cresci • Kevin Smeets • Laetitia Plisson

RAILROADS HAVE ALWAYS been part of the urban landscape—from the suburban stations where commuters board for their daily ride into town to the subways under the streets speeding people from one metro hotspot to the next. But urban mobility is changing rapidly with the influx of new travel modes and technologies that could potentially undermine the role of passenger rail and mass transit in cities.

Ridesharing is a harbinger of the challenge that lies ahead. Over the next decade, many cities will see the development of autonomous cars, drones, smart parking, and even an entire digitized, connected traffic management system. City planners need to anticipate how new mobility solutions will coexist with mass transit, not replace it. Moving forward, large cities will still need modern passenger rail to remain a central part of the urban mass transit mix—or suffer the consequences.

Why will rail be so important? First, cities are getting bigger. By 2050, there will be 30 percent more megacities—those with over 10 million inhabitants; many of these will be in developing countries. City residents and commuters in most major metropolitan areas have already been living with urban gridlock and the haze of atmospheric pollutants. Think Beijing as one of the most dire situations, but there are many other cities suffering similar congestion and polluted air. Even with increased electrification of transportation to help

reduce pollution, city streets simply don't have enough capacity to absorb all the trips generated by people and products moving into and out of major cities each day.

Quick and efficient

Rail remains the quickest and most cost-effective transportation mode for moving large numbers of people. At average occupancy, a single heavy-rail commuter train can transport nine times as many people in one hour as one traffic lane of cars. One million riders on the busiest commuter rail line in Paris, the RER A, is equivalent to 28 city traffic lanes, which can be used to meet other needs.

There is also no room in most urban areas on which to build more roads anyway. In the densely populated urban area between and around Tokyo and Yokohama, Japan, 19 rail lines move four million people daily. To match that, road capacity would have to expand the equivalent of eight highway lanes in both directions between these two major cities. Besides the substantial expense, where would city planners put the additional roadway?

The second trend contributing to urban congestion is the explosion of e-commerce. Over the last decade, delivery trucks rushing to meet two-day, next-day, and same-day delivery schedules have increasingly clogged city streets. The new urgency of deliveries and the

increased congestion from them has lengthened urban travel times and made streets more dangerous—with traffic fatalities worldwide on the rise. This is not to suggest that e-commerce should move its deliveries to rail—that wouldn't be viable. It is a recognition that e-commerce is making the movement of people via road much more difficult and much less cost-effective.

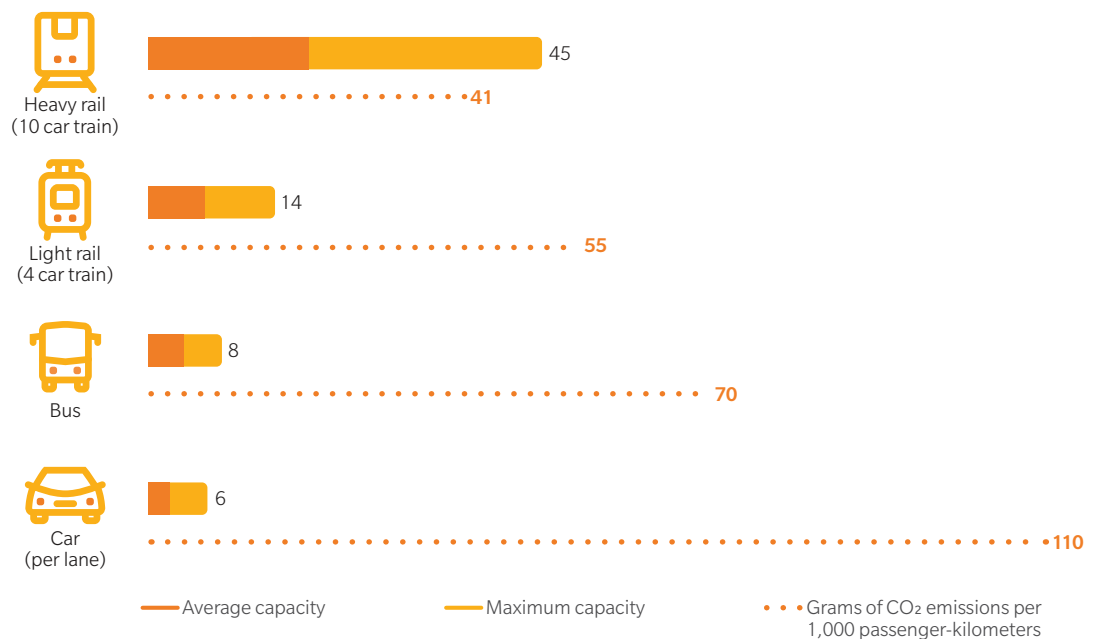
Boxes everywhere

A third development that spells trouble for urban congestion is the rapid rise in both ride-hailing and the use of private cars since the global recession and the decline in gasoline prices. Despite the much-discussed millennial aversion to owning cars, the number of cars in many major cities is increasing, in part because of those owned or employed by ride-hailing companies.

The increase is beginning to eat into mass transit revenue as people choose car over subway or bus. In the United States, vehicle miles traveled in private cars have increased in every year since 2013. Simultaneously, study after study—including one by the ride-hailing industry—confirm that cars-on-demand are only helping to snarl city and suburban traffic, simultaneously compounding the pollution problem.

Many cities have tried to discourage the use of cars and car ownership—but not always successfully.

URBAN COMMUTING TRANSPORT CAPACITY AND RELATIVE CARBON DIOXIDE EMISSIONS



Source: **Oliver Wyman analysis**

Singapore has congestion pricing to discourage the use of cars and a deliberate policy of making car ownership very expensive. In 2018, the city announced a cap on the number of private cars because of the scarcity of land and to support the city's commitment to public transport upgrades. As a result, Singapore has a significantly lower rate of car ownership than the US—11 percent versus 80 percent—and Europe, which has a rate of about 50 percent. Perhaps not coincidentally, the city also boasts one of the best, most affordable public transit systems in the world.

Earth friendly

Increasing the use of rail mass transit also could help large cities manage the multiplying demands made on streets. For instance, most major cities are facing pressure to create bus-only rapid transit lanes, e-bike and e-scooter lanes, and parcel delivery/rideshare drop-off lanes—requests that become more difficult and more expensive to fill when the traffic lanes are already overcrowded.

Of course, the most obvious reason to switch to rail is the prospect of reducing greenhouse gas emissions. Depending on the type of train, rail emits anywhere from 30 percent to 70 percent less carbon dioxide than conventional cars—and even less than electric cars.

For rail to maintain its dominant role in urban mobility for large cities, it will need to become more fully integrated with other transport modes. This means, for example, making over urban train stations into smart multimodal hubs, able to add physical connections quickly as mobility evolves. These hubs might include boarding points for on-demand and autonomous buses and cars, e-bike and e-scooter parking, and roof spaces for advanced vertical takeoff and landing aircraft.

Digitally integrated hubs

Rail also must be digitally integrated through station upgrades and mobility apps that focus on the user experience, such as those that provide real-time information on connections and on-demand first-mile/last-mile transport options. Digital technology will not only help commuters plan and execute multimodal journeys but also ease operational constraints that affect commuters.

And urban commuters are likely to be appreciative. *Oliver Wyman research* has shown that 92 percent of car drivers would willingly switch to public transportation—if they were guaranteed access to “smart mobility” services that make their time commuting useful and enjoyable.

London is one example of a concerted effort to improve urban rail integration. Train stations there have been renovated to offer multimodal connectivity and

Rail emits anywhere from
30 percent to 70 percent less
CO₂ than conventional cars—
and even less than electric cars

a wide range of commercial and leisure services. And Transport for London, an integrated transport authority, is supporting open data exchange to ensure efficient and balanced public transport services and to soften the impact of disruptions. Its website becomes a one-stop shop for the city's mass transit.

Easy pay

Ease of payment—expanding the common “metro card” for commuting from Point A to Point B—is the final leg of integration. Hong Kong commuters, for example, can use the Octopus smart card to pay for public transport, taxis, parking, shopping, and even as a key card to access office and residential buildings.

Urban mobility is undergoing an unprecedented evolution. Ensuring that rail remains the vital link connecting commuters to city streets will require operators and cities to invest in station upgrades and to partner with technology startups. The goal must be to develop integrated and interconnected mobility solutions with passenger rail as the centerpiece.

Jean Pierre Cresci

is a Paris-based partner in Oliver Wyman's transportation and services practice and its operations practice.

Kevin Smeets

is a Paris-based partner in Oliver Wyman's transportation and services practice and its operations practice.

Laetitia Plisson

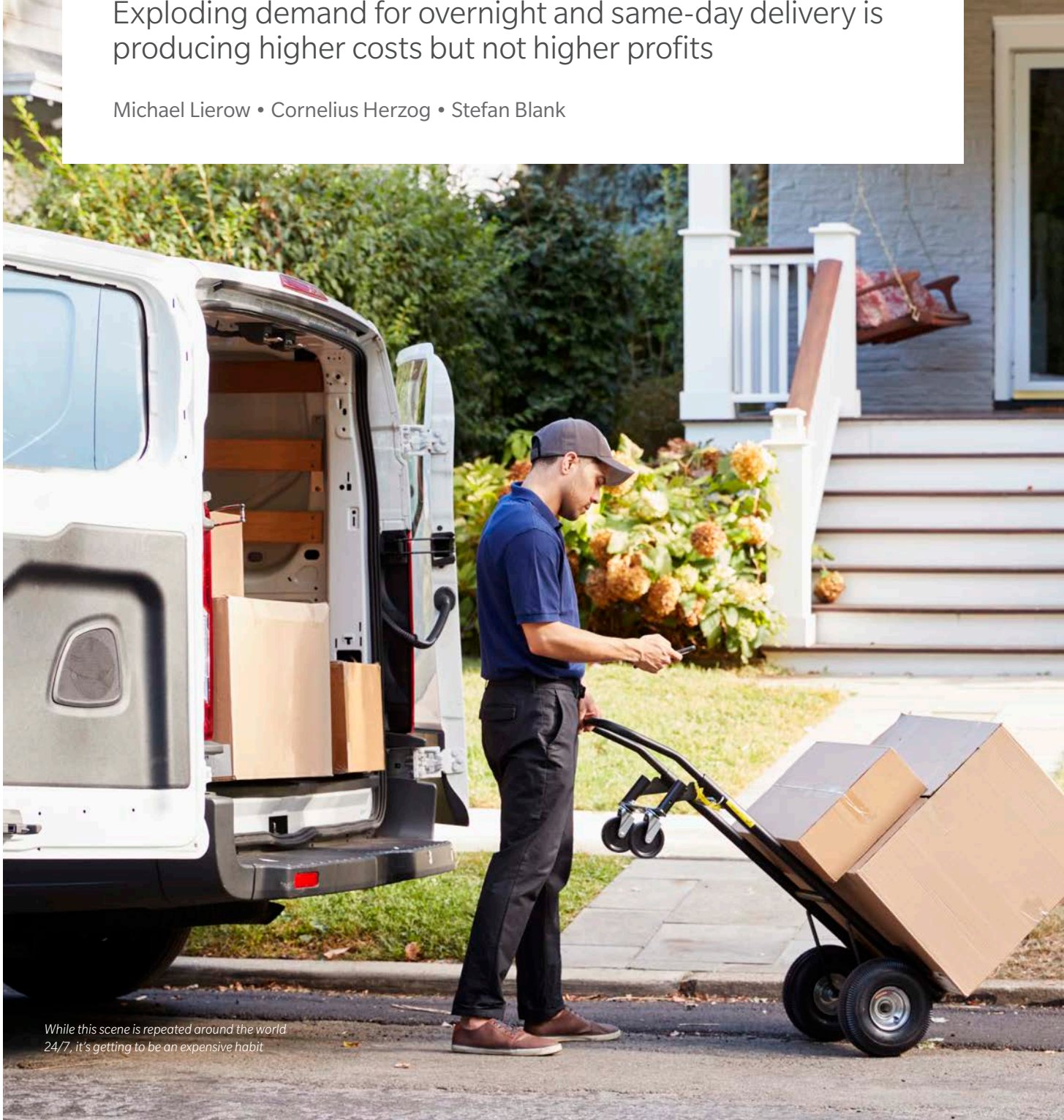
is a Paris-based principal in Oliver Wyman's transportation and services practice and its operations practice.

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WHY CHEAP HOME DELIVERY MAY DIE

Exploding demand for overnight and same-day delivery is producing higher costs but not higher profits

Michael Lierow • Cornelius Herzog • Stefan Blank



While this scene is repeated around the world 24/7, it's getting to be an expensive habit



YOU KNOW HOW great it is to go online, place an order with no or low shipping fees, and find it outside your door 24 or 48 hours later? Well, those days may be coming to an end.

With e-commerce shipments booming globally, the economics of making millions of single-parcel deliveries daily to millions of households is becoming unsustainable as shipping costs increase and the ability to pass higher prices along isn't necessarily following. Even when drones and autonomous vehicles finally begin to make deliveries—perhaps as much as a decade from now—they are more apt to be delivering to central pickup locations than zooming around busy city streets for private home drop-offs. And even these revolutionary technologies will need an army of human logistical workers to keep the volume of packages flowing.

In any case, that future hasn't arrived yet. For now, the parcel delivery industry needs to figure out how to make money keeping up with Amazon and other e-commerce giants and the relentless growth they are generating. While the double-digit growth is keeping delivery companies busier than ever before, mounting pressures on their networks—from labor shortages to the rise in single-package deliveries—are cutting into profitability, and revenue per shipment has dropped steadily over the past decade.

A business model in flux

Part of the problem stems from the failure of the industry to recognize and adapt to its changing business model. For years, much of parcel company work consisted of business-to-business shipments between, say, a clothing manufacturer and a retailer. Today that business is being dwarfed in volume by massive deliveries direct to consumers.

This has dramatically reduced the so-called drop factor of parcel companies—that is, the number of parcels delivered per stop or recipient. As the drop factor has fallen, the costs of last-mile delivery have risen. While the normal response would be for parcel delivery companies to raise prices, e-commerce giants have gained leverage to negotiate good deals because of their ever-expanding volume of parcels. As a result, costs—thanks to increases in labor and equipment—are up 17 percent since 2007, while prices per parcel are down four percent, according to Oliver Wyman estimates.

The last mile of delivery accounts for more than half of the shipping cost

Another big challenge for the industry today is the volatility of demand. Parcel firms are particularly under pressure when shipments surge as they do on certain days of the week and during seasonal peak periods. Christmas shopping alone sends volumes up more than 300 percent, and other events—Black Friday and China’s Singles Day—cause similar spikes. Even during a typical week, volumes fluctuate 30 percent to 40 percent. Add onto that an increase in same-day and next-day delivery as retailers compete against each other for business.

This volatility means that demand for drivers and sorting facility personnel is also constantly changing, a trend difficult to handle with full-time workers looking for predictable schedules. But companies don’t have an easy option trying to work with temporary staff. Given labor shortages in most industrial nations, companies can’t assume drivers or warehouse employees will be available when they need them. Predictably, wages

have been rising as they do in shortages, eating further into profits.

Finally, utilization of facilities will be uneven and probably not optimal when there is volatility and lack of predictability in the volume of work. This, plus rising labor costs, cuts into profits.

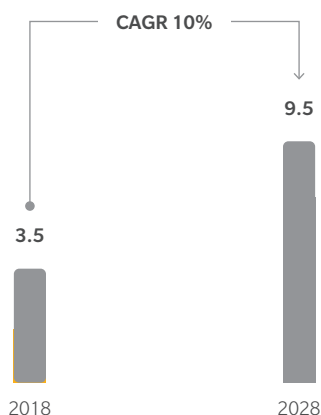
Staying a step ahead

Rather than curbing business growth with extensive price increases, companies may be able to use technology to gain an advantage. While parcel delivery has gained a high-tech image, thanks to scannable tracking codes and mobile terminals, the industry and the underlying operations are in many respects old-fashioned, still based on an earlier business-to-business model that was easy to predict. For that reason, the industry faces a high ratio of fixed costs to variable—about 70 percent to 30 percent. One way to help margins would be to reduce the percentage of fixed costs.

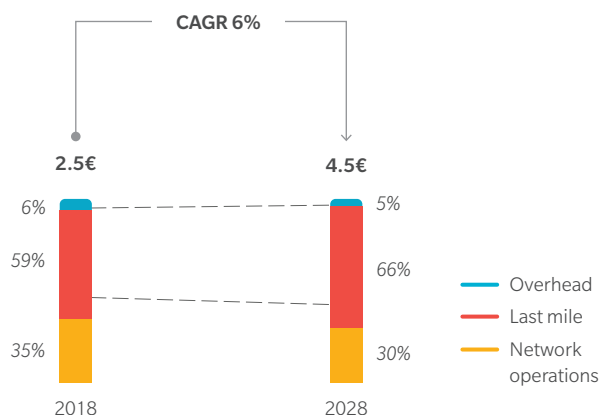
A 21st century solution would be to adopt more predictive analytics and artificial intelligence in operations, which would provide the computer power and data analysis needed for smarter management of delivery networks. Incorporating these latest technologies would give parcel companies the ability to better anticipate volume and make corresponding adjustments to their use of depots, routes, and personnel. Early pilot projects have shown that these

THE GROWTH OF PARCEL VOLUME IN GERMANY

Parcel volume growth, in billions of parcels

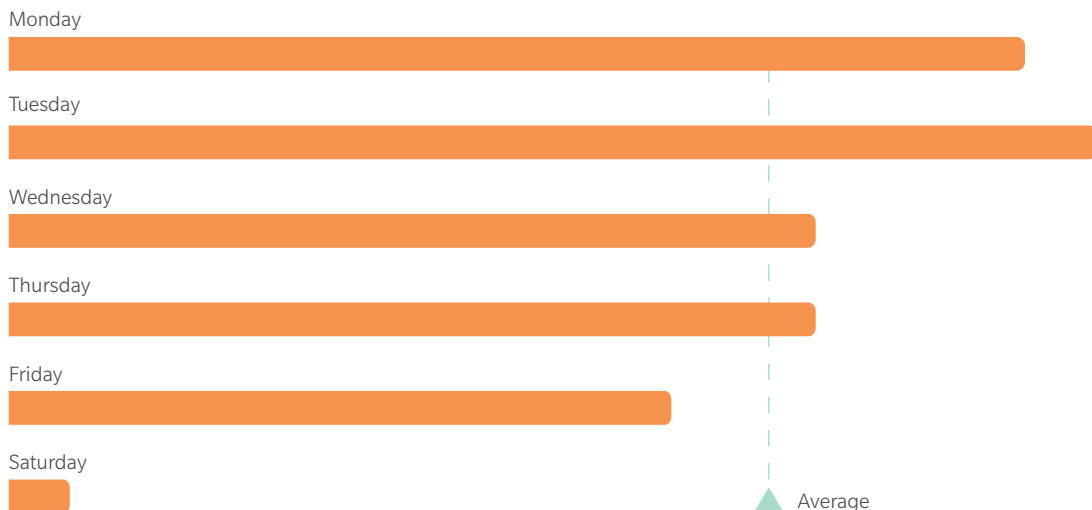


Direct cost per parcel, in EU €



Source: Oliver Wyman analysis

HOW PARCEL VOLUME CAN FLUCTUATE



Source: Oliver Wyman analysis

new technologies can yield cost improvements of anywhere from two to five percent.

With these technologies, companies can expand and get more granular in their forecasting. While advanced forecasting does not prevent fluctuations in volume, it does open up a variety of new ways to plan for them.

For instance, the network of depots can be configured differently according to the day of the week. If a sorting facility has been quiet on Fridays, then packages can be diverted to a busier sorting center, enabling more efficient use of assets and personnel. On busy days, a direct shipment route between two cities might be justified, but on slower days shipments could take an indirect route through a central sorting facility to ensure trucks are always filled to the maximum. Sorting staff can be deployed when and where they are most needed. The aim is not to reduce the numbers of personnel or facilities, but to use workers and depots more efficiently.

The last mile

The last mile of delivery is especially important, as it accounts for 50 percent to 60 percent of the costs for shipping a parcel. Today, delivery routes are planned in a static way, with the same driver plowing the same route without deviation. Smart forecasts can help to replot routes every day to make the best use of available drivers and vans.

Self-learning algorithms can acquire knowledge of where the good parking spots are, how much

time is needed per stop, and the impact of traffic at different times. With practice, the algorithms will become progressively better at planning routes and improving efficiency.

But the competition is intense, and those who hesitate to adopt 21st century technologies may pay a high price. Even though this year's rate increases will help with margins short-term, it's a slippery slope and rivals can easily reverse that progress by cutting their own costs and prices by uncovering new efficiencies.

Michael Lierow

is a Munich-based partner, who specializes in logistics, in Oliver Wyman's transportation and services practice and the operations practice.

Cornelius Herzog

is a Munich-based principal in Oliver Wyman's transportation and services practice and the operations practice.

Stefan Blank

is a Munich-based engagement manager in Oliver Wyman's transportation and services practice and the operations practice.

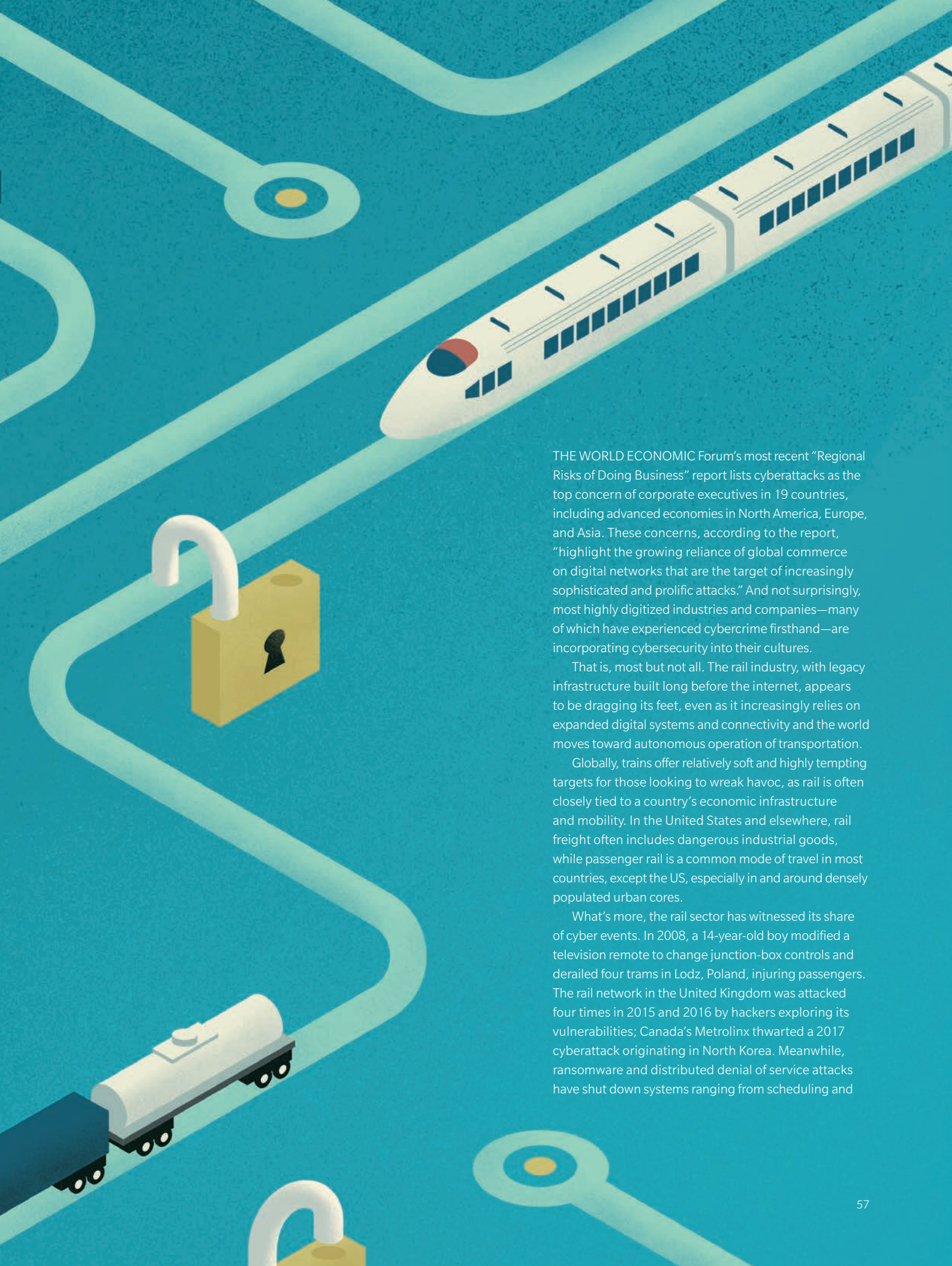
This article first appeared in [Forbes](#) on February 28, 2019.

IN NEED OF CYBER RESILIENCE

Rail has been slow to modernize, but it can't drag its feet on cybersecurity any longer

Patrick Lortie • Paul Mee • Brian Prentice





THE WORLD ECONOMIC Forum's most recent "Regional Risks of Doing Business" report lists cyberattacks as the top concern of corporate executives in 19 countries, including advanced economies in North America, Europe, and Asia. These concerns, according to the report, "highlight the growing reliance of global commerce on digital networks that are the target of increasingly sophisticated and prolific attacks." And not surprisingly, most highly digitized industries and companies—many of which have experienced cybercrime firsthand—are incorporating cybersecurity into their cultures.

That is, most but not all. The rail industry, with legacy infrastructure built long before the internet, appears to be dragging its feet, even as it increasingly relies on expanded digital systems and connectivity and the world moves toward autonomous operation of transportation.

Globally, trains offer relatively soft and highly tempting targets for those looking to wreak havoc, as rail is often closely tied to a country's economic infrastructure and mobility. In the United States and elsewhere, rail freight often includes dangerous industrial goods, while passenger rail is a common mode of travel in most countries, except the US, especially in and around densely populated urban cores.

What's more, the rail sector has witnessed its share of cyber events. In 2008, a 14-year-old boy modified a television remote to change junction-box controls and derailed four trams in Lodz, Poland, injuring passengers. The rail network in the United Kingdom was attacked four times in 2015 and 2016 by hackers exploring its vulnerabilities; Canada's Metrolinx thwarted a 2017 cyberattack originating in North Korea. Meanwhile, ransomware and distributed denial of service attacks have shut down systems ranging from scheduling and

information to internal communications and ticket selling at the San Francisco Muni, Deutsche Bahn in Germany, and Danish train operator DSB. While not crippling, these forays hint at the potential for damage and indicate that it's high time for the industry to develop more cyber resiliency.

The scope of risk

There are as many as 300,000 hackers worldwide, and that number is growing. Organized crime, hackers, and nation states are part of the mix and constantly innovating, meaning that the severity and frequency of attacks is likely to increase.

Rail networks are particularly at risk because they are extensive, dispersed, and complex. Despite modernization, critical infrastructure is still made up of legacy components not originally designed and deployed with cyber resilience in mind. Transportation systems also are increasingly interconnected and connected to the internet. The continued introduction of new and connected technologies, such as Internet of Things sensors and tools, further widens the "surface area" vulnerable to cyberattack. The introduction of

machine-learning and artificial intelligence is expected to lead to even more potent and targeted cyberattacks.

In the US, the rollout of positive train control (PTC) on 65 percent of the rail network could be of notable interest to bad actors. PTC represents a new application of a complex web of technologies, such as GPS, wireless, cellular, and radio communication, and PTC installations have largely eliminated legacy signal systems that were air-gapped. PTC is designed to improve rail safety by preventing train collisions and derailments, yet its cyber vulnerabilities and security weaknesses might be easily exploited, thus creating new safety concerns.

Other liabilities include the use of open-source software and software with outdated security patches (which the 2017 WannaCry ransomware attack exploited). In addition, railroads, like other asset-intensive industries, typically do not have a culture of cyber awareness, which makes their workforces vulnerable to social engineering, such as phishing, and the misuse of portable storage and other intrusion-enabling devices.

Finally, technology architectures typically contain legacy components from third- and fourth-party providers, making vulnerabilities, often deep in the

FEATURES OF AN ADEQUATE CYBER ASSESSMENT

	RISK MEASUREMENT	Fully understand cyber risk exposure and the underlying drivers of losses.
	RISK MANAGEMENT	Ensure that cyber risk can be comprehensively managed across the organization.
	RESPONSE	Be prepared to respond quickly and in a structured way to a cyberattack, to minimize stakeholder impact.
	INVESTMENT PORTFOLIO	Evaluate investments across the cyber risk mitigation spectrum and relative to other investment demands.
	EXECUTIVE OVERSIGHT	Continuously monitor cyber risk exposure status, trends/outlook, and the impact of investments.
	INSURANCE	Determine cyber coverage strategy and the nature/extent of premiums.

Source: Oliver Wyman analysis

technology stack, difficult to discern and address. Hardware as well as software is exploitable; for example, the Chinese government reportedly infiltrated the networks of major US corporations by inserting nearly undetectable microchips into computer servers built by Chinese companies. This has led to US lawmakers expressing concerns over state-owned China Railway Rolling Stock Corp. bidding on a contract to supply new rolling stock for the Washington Metro. In response, the Metro has tightened cybersecurity requirements for the tender, but some doubt these go far enough.

An attack's fallout

The cyber risks for rail are many, including financial losses, compromised infrastructure, scheduling and communications breakdowns, theft of private data, safety liabilities, and reputational risk. In the EU, scheduling and information blackouts have shut down trains and stranded passengers, leading to lost revenues and network disruptions. The most serious concern, of course, is the physical safety of the rail network. PTC, digitally controllable locomotives and train components, and expanding wireless data streams all make the threat of a hacker-caused train collision or derailment real.

Beyond direct financial losses, post-attack recovery can be costly: When JPMorgan Chase was hacked in 2017, direct losses in the millions were followed by cybersecurity investments—over \$500 million in the year that followed the incident. Similarly, the world's largest shipping company, A.P. Moller-Maersk, was hit by ransomware in 2017 that disrupted operations at terminals in four countries for weeks, generating recovery costs of up to \$300 million.

Concerns over the potential impacts of cyberattacks also raise the threat of additional regulation or shipper requirements that railroads guarantee the integrity of product and transportation data. Stricter cybersecurity laws may be in the offing for infrastructure considered critical to a country's economy and security. The EU, for example, has implemented a Network and Infrastructure Security directive to standardize cybersecurity protocols for "essential services," while the US created the Cybersecurity and Infrastructure Security Agency (CISA) as a new federal regulatory agency in late 2018.

Beefing up defenses

Cyber resilience—the ability to prepare for, react to, and move past a cyberattack—must be high on the agenda of rail executives and board members. Fortunately, railroads can learn from and in some cases leapfrog other industries that have experienced daunting cyberattacks firsthand, such as finance and healthcare.

Most critically, an organization's outlook in terms of preparedness for cyberattacks needs to be a "when—not if" mentality. Railroads should assume a cyberattack will happen and develop a robust and responsive risk-management system. This starts with asking the right questions to fully understand the threat landscape and all the components of risk and response that must be developed and managed.

Effective cybersecurity begins by articulating a strategy in response to these questions, supported by an assessment of the company's current preparedness, appetite for risk, and quantification of economic exposure. A cyber operating model can be used to assign roles and responsibilities, while a cyber dashboard can monitor threat metrics and elevate discussion to the executive/board level. Finally, cyber playbooks need to be developed that step through how to handle major incidents, including accountabilities and response/recovery actions.

A valuable input to this process can be simulating various attacks on the organization, based on the threat landscape and prior attacks on other companies, to determine preparedness and resiliency. Working sessions with employees can uncover their knowledge about specific security weaknesses and gaps in oversight, controls, and access.

Railroads are complex, unique environments. Managing cyber risk and building appropriate defenses for railroads are not easy tasks, given the mix of legacy components that railroads have inherited and the advanced technologies they are embracing. But make no mistake: Cyber resiliency is a clear and urgent necessity in today's digital world.

Patrick Lortie

is Oliver Wyman's global rail practice leader and a partner based in Montreal.

Paul Mee

is a New York-based partner in Oliver Wyman's digital, technology and analysis practice.

Brian Prentice

is a Dallas-based partner in Oliver Wyman's transportation and services practice and its operations practice.

This article first appeared in [Railway Age](#) on March 21, 2019.





DISRUPTING AUTO SALES

Centralizing distribution can reduce the
need for dealer inventory

Jason Kuehn • Joern Buss

DESPITE THE MASSIVE transformation in automobiles about to take place—from the proliferation of electric vehicles to the advent of fully autonomous ones—one thing that hasn't changed in the past century is the way most new cars are sold. In North America, cars are shipped from the manufacturer to franchised dealerships, where they sit in stock until sold. Inventory that sits around waiting for a buyer isn't just taking up room, it's also soaking up money.

Typical inventories are 60 to 90 days of vehicles with a value of \$60 billion to \$93 billion, depending on the mix of models and whether they are assessed at their cost to the manufacturer or the

The carrying cost of this inventory, even at current low interest rates, is \$3 billion to \$5 billion

market value. Just the carrying cost of this inventory, even at current low interest rates, is \$3 billion to \$5 billion, not to mention the one-time cost of the inventory and all the real estate needed to store it. The system is an inefficient hangover from pre-digital days.

Thanks to the increasing digitization of the supply chain and the adoption of new distribution and logistics practices, these costs could be reduced by a third, saving \$60 to \$90 per vehicle, or as much as \$1 billion to \$1.5 billion a year. Much of the technology and tools to do this already exist—and more are on the way. Just look at the success of Tesla's approach to sales and distribution: Selling cars online without even a test drive speaks volumes about the potential for a faster, less inventory-intensive process.

Car buying reimagined

Many consumer industries are changing because of customer demands for greater transparency and fewer hassles, and many would agree that car buying is ripe for reform. According to the 2019 Cox Automotive

survey, around a third of car buyers dislike dealership negotiations and paperwork processes, and 58 percent resent the time they must spend at the dealership.

This has led to a surge in online car shopping. Rather than deal with dealerships, buyers are spending 61 percent of their time online to narrow down the vehicle type and options they want, determine pricing, and even purchase cars outright, the Cox survey shows.

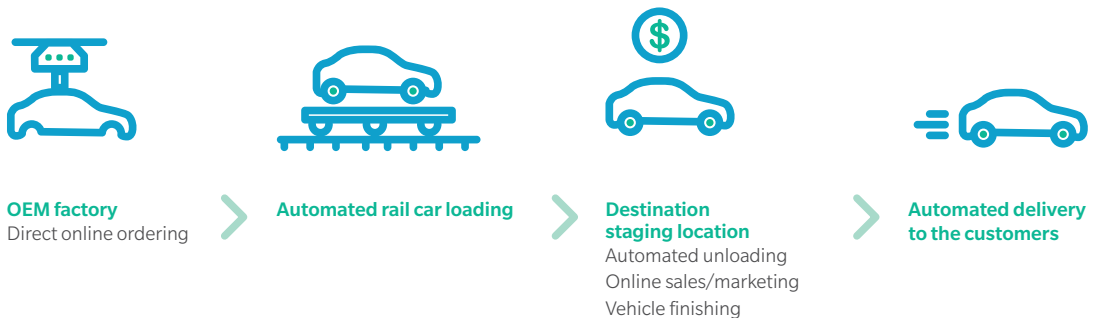
Moving a large chunk of car buying online helps lock in today's tech-savvy customers with price transparency, online customization and financing, and standardized delivery dates. Costco's Auto Program, which offers discounts and streamlines the purchase process for new and pre-owned cars, has seen sales rise from 400,000 vehicles in 2014 to an estimated 650,000 in 2018. Online-only companies such as Carvana and NowCar let customers skip the dealership and offer no-haggle pricing for used cars. Even some new-car dealerships are testing the waters of online purchasing.

Digitizing distribution

Just as going online is making car shopping less painful, digitization and the internet could also make the distribution and delivery of cars a faster, less clunky process. Car inventory on dealer lots is kept high partly because of the perceived cost of "stock out"—one dealership losing a sale to another because it doesn't have the buyer's desired vehicle in stock. If dealers could get cars with the right options quicker, it would lessen their need to maintain so much inventory. Predictive analytics and advanced algorithms that anticipate option preferences can make that process smarter and faster.

The finished-vehicle supply chain doesn't have to be so costly and dealer lots so vast. As Tesla has shown,

VEHICLE SUPPLY CHAIN REIMAGINED



Source: **Oliver Wyman analysis**

the car lot of the future might feel more like an Apple store, where customers can touch, “test drive,” and get their questions answered while a limited inventory is kept on hand.

Centralizing the process

Distribution could become more centralized. For example, manufacturers could pre-distribute cars close to urban areas—creating automobile “fulfillment centers” not unlike those used by Amazon and other retail giants to get inventory to customers quickly. Using rail terminals as inventory staging points could help get this change off to a fast start, given that up to 60 percent of all finished vehicles are shipped by rail on their way to dealerships.

Just as Amazon seeks to optimize its footprint to minimize inventory costs, analytics could determine how many distribution sites are needed and where they should be located to reduce inventory and supply chain cost, delivery time to customers, and situations of dealers not having the stock to meet customer needs. Predictive forecast models can be developed using market size, brand sales, transportation costs and time, and the perceived cost of lost sales because vehicles are out of stock.

With these centers in place, manufacturers could either keep using the dealership network or not, depending on state laws. As customers visit dealerships—or buy online—cars could be pulled from fulfillment center inventory, cleaned up, additional options installed, and delivered direct to customers within a short window. This might eliminate as much as 30 days of inventory from the supply chain and one million automobiles from inventory in the US alone.

In the US, the used car market is already moving toward this model. Carvana, for example, has built regional “reconditioning centers” that inspect, certify, and store cars until purchased.

More disruptors

Eventually, the arrival of autonomous vehicles may also speed up the distribution system. Autonomous cars would have the capability of driving directly from the railyard to a customer’s garage. They would likely be able to load and unload themselves from railcars with flat decks, making for a faster, less labor-intensive process. Hauling vehicles by truck, in comparison, is more difficult to automate, as each vehicle needs to be individually positioned on a hydraulic rack.

Another change coming to car sales is a possible transition from a marketplace dominated by individuals

Rather than deal with dealerships, buyers are spending 61 percent of their time online to narrow down choices

buying vehicles to one focused on fleet sales. It would be a byproduct of the success of ride-hailing and other business models that provide convenient access to cars without ownership. In such a market, the current finished-vehicle supply chain would morph from B2C to B2B and further support a centralized inventory model.

In the meantime, defining sought-after options through advanced algorithms, staging new car inventory more efficiently, and using online tools for car purchasing—from negotiating the price and specifying options to completing the paperwork—could improve service while slashing inventory costs and eliminating as many as one million automobiles from US inventories.

Jason Kuehn

is a Princeton, New Jersey-based vice president in Oliver Wyman’s transportation and services practice.

Joern Buss

is a Detroit-based partner in Oliver Wyman’s automotive practice.

HOW TO CONTACT OUR AUTHORS

AVIATION GRIDLOCK

Taylor Cornwall
Taylor.Cornwall@oliverwyman.com

Michael Khan
Michael.Khan@oliverwyman.com

FLYING HYBRIDS

Jerome Bouchard
Jerome.Bouchard@oliverwyman.com

Eric Confais
Eric.Confais@oliverwyman.com

MARGIN SQUEEZE

Tom Stalnaker
Tom.Stalnaker@oliverwyman.com

Grant Alport
Grant.Alport@oliverwyman.com

Andy Buchanan
Andy.Buchanan@oliverwyman.com

Aaron Taylor
Aaron.Taylor@oliverwyman.com

REVERSING COURSE

Tom Cooper
Tom.Cooper@oliverwyman.com

Brian Prentice
Brian.Prentice@oliverwyman.com

David Stewart
David.Stewart@oliverwyman.com

SILICON VALLEY EAST

Heiko Rauscher
Heiko.Rauscher@oliverwyman.com

FROM TOY TO TRANSPORT

Anthony DiNota
Anthony.DiNota@oliverwyman.com

Steve Douglas
Steven.Douglas@oliverwyman.com

Dave Marcontell
David.Marcontell@oliverwyman.com

BOXED IN BY SUCCESS

Bruce Spear
Bruce.Spear@oliverwyman.com

Matthew Schabas
Matthew.Schabas@oliverwyman.com

THE FUTURE IS BIOMETRIC

Alex Hill
Alex.Hill@oliverwyman.com

Helena Bononi
Helena.Bononi@wttg.org

Scot Hornick
Scot.Hornick@oliverwyman.com

Mike Matheis
Mike.Matheis@oliverwyman.com

HAPPY CUSTOMER, HEALTHY COMPANY

Scot Hornick
Scot.Hornick@oliverwyman.com

Jessica Stansbury
jessica.Stansbury@oliverwyman.com

Jatin Goradia
Jatin.Goradia@oliverwyman.com

Alex Hill
Alex.Hill@oliverwyman.com

THE SUPER INFORMED TRAVELER

Marianne Connault
Marianne.Connault@oliverwyman.com

Bruno Despujol
Bruno.Despujol@oliverwyman.com

Simon Glynn
Simon.Glynn@lippincott.com

WHY CITIES NEED RAIL

Jean Pierre Cresci
JeanPierre.Cresci@oliverwyman.com

Kevin Smeets
Kevin.Smeets@oliverwyman.com

Laetitia Plisson
Laetitia.Plisson@oliverwyman.com

WHY CHEAP HOME DELIVERY MAY DIE

Michael Lierow
Michael.Lierow@oliverwyman.com

Cornelius Herzog
Cornelius.Herzog@oliverwyman.com

Stefan Blank
Stefan.Blank@oliverwyman.com

IN NEED OF CYBER RESILIENCE

Patrick Lortie
Patrick.Lortie@oliverwyman.com

Paul Mee
Paul.Mee@oliverwyman.com

Brian Prentice
Brian.Prentice@oliverwyman.com

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Jason Kuehn
Jason.Kuehn@oliverwyman.com

Joern Buss
Joern.Buss@oliverwyman.com

Introducing the Oliver Wyman Forum

In 2019, Oliver Wyman launched an initiative, separate from our commercial operation, for the purpose of tackling some of the biggest economic and social challenges facing global industry and society. Our approach involves convening some of the best thinkers from business, public policy, academia, and social enterprise to inspire research, analysis, and action. This is not just about launching studies but rather building coalitions of stakeholders across industries and geographic boundaries. Our goal is to develop a more collaborative way to deal with technological disruption and work toward more equitable and effective remedies to mitigate its impact and enhance its potential.

Leading the Oliver Wyman Forum is John Romeo, a member of the firm's executive committee and a guiding force behind its social impact program. Romeo and a team of Oliver Wyman partners will use several topic lenses, including the future of mobility, cyber risk, and the readiness of cities to compete in the age of artificial intelligence, as a framework for Forum discussion and research.

THE FUTURE OF MOBILITY

One of the first targets will be to assess the transformative impact of New Mobility and its key technologies on global economies and everyday lives. The lines between industries and modes of transportation are blurring, and in their place complex sets of overlapping ecosystems are evolving to serve the planet's daily needs. By 2030, mobility-related businesses are projected to contribute one-quarter of the world's gross domestic product, and they are already starting to redefine the movement of people and goods.

The Mobility initiative is working with key stakeholders from transportation, communications, and energy companies, technology innovators, insurers and other risk managers, academics, and governments. The world will be our laboratory as we conduct working sessions in key frontiers of change—from centers of new technology and finance like San Francisco, Shanghai, and New York to hubs of city reinvention like Dubai and Singapore.

Among the issues the Forum's Mobility team will probe:

- The transition to sustainable mobility
- The rise of autonomous vehicles and systems
- Changing mobility implications for telecom networks and electric grid infrastructure requirements
- Ownership versus sharing
- The creation of international technology standards to streamline interoperability

THE GLOBAL MOBILITY EXECUTIVE FORUM

The Mobility initiative is launching a series of collaborative workshops with senior leaders from industry, public policy, finance, and technology.

These will be held around the globe, starting in Paris in the fall of 2019. For information on upcoming executive sessions, please visit OliverWymanForum.com.

Oliver Wyman transportation, energy, and communications experts leading the Mobility Initiative

Francois Austin
Partner & Head of the
energy practice

Francois.Austin@oliverwyman.com

Guillaume Thibault
Partner & mobility
initiative fellow

Guillaume.Thibault@oliverwyman.com

Moe Kelley
Partner & mobility
initiative fellow

Moe.Kelley@oliverwyman.com

Laetitia Plisson
Principal

Laetitia.Plisson@oliverwyman.com

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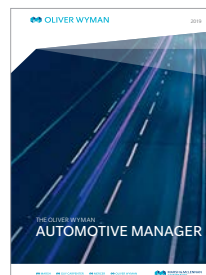
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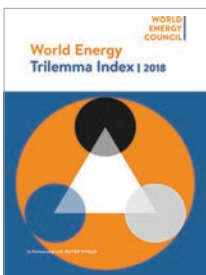
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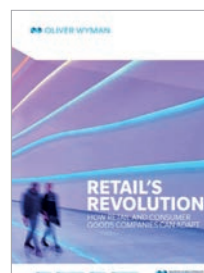
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