AVIATION

IN THE AGE OF SUSTAINABLE URBANIZATION

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The Modern Silk Road: Aviation in the Age of Sustainable Urbanization

In the ancient world, the Silk Road was a vast network of trade routes traversing Asia, connecting East and West. Towns and cities that lay along these routes benefited from stronger economies, improved political ties, and a steady exchange of new ideas. The ancient Silk Road strengthened communities from China to the Mediterranean Sea.

In today's rapidly urbanizing world, global air transport has become the modern Silk Road. Commercial aircraft crisscross the planet, carrying people and goods, and helping to connect isolated regions to the global community. Cities look to aviation to strengthen their economies and improve their quality of life.

Once, being connected to the Silk Road was an advantage. In the 21st century, it is a necessity.

IN BRIEF

- Urbanization is one of the megatrends of the 21st century. The share of the world's population that resides in cities will grow from more than half today to nearly two-thirds by 2050.

- The growth of cities will create new wealth and support a middle class that could number 5 billion people by 2030, with the fastest growth in Asia and the developing world. This booming population segment will seek greater access to opportunities and services—including a skyrocketing demand for commercial aviation.

- To meet this need, the number of commercial aircraft in service is expected to grow from about 26,000 today to approximately 46,000 by 2030.

- Commercial aviation will play a fundamental role in developing sustainable cities by raising standards of living and enhancing the creation of healthy urban environments.

In 2007, for the first time in human history, more people around the world lived in cities and towns than in rural areas.[1] A global urban population totaling just 746 million in 1950 ballooned to 3.9 billion people in 2014. The United Nations forecasts the addition of 2.5 billion more city dwellers by 2050, meaning two out of every three human beings will live in an urban area.

Of course, the pace of urbanization will vary dramatically from region to region. While still continuing to grow, North America, Latin America, and the Caribbean (at about 80 percent combined) are the most urbanized areas in the world. The most rapid growth will occur in developing regions. The urban population in Africa, for example, is expected to grow from 40 percent to 56 percent by 2050. In Asia, the proportion of city dwellers over that same period will increase from 48 percent to 64 percent. India, China and Nigeria alone will account for more than one-third of the projected growth of the world's urban population between 2014 and 2050.

Urban and Rural Population of the World

SOURCE: ANNEX, TABLE 1, "WORLD URBANIZATION PROSPECTS," UNITED NATIONS, 2014 REVISION — URBAN — RURAL

Cities vary dramatically in size, from megacities with more than 10 million inhabitants to cities of fewer than 500,000 inhabitants. In every case, however, urban landscapes are focal points for trade and tourism, requiring world-class mobility both within the city and to connect its residents with the outside world.

Urbanization is one of the megatrends of the 21st century, and history tells us that this could be a very good thing. Cities have long been the source of humanity's best ideas and most vibrant culture. Cities are also where wealth is created; capital and markets are accessible, innovation is prized, and labor is put to productive use. Few places can lift people from poverty to prosperity faster than a healthy city.
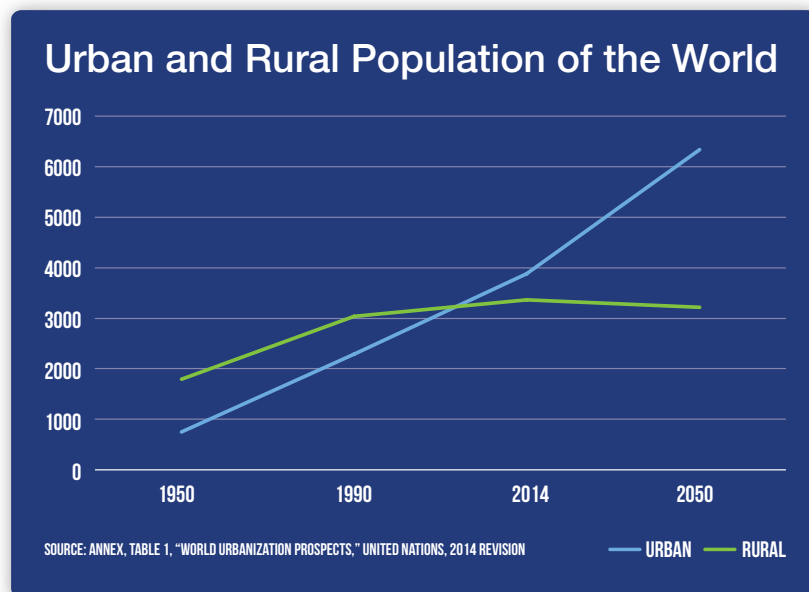
Why do cities work? Because they foster physical connections, allowing human beings to work face to face. In other words, cities optimize human capital. For all the benefits of modern communications, from smartphones to the Internet, people still collaborate best through personal contact. "The strength that comes from human collaboration," one observer believes, "is the central truth behind civilization's success and the primary reason why cities exist."[2]

The numbers bear this out.

Cities are able to generate improvements referred to as "superlinear scaling," the result of economies in production and distribution, the ability of industry players to cluster, the attraction of diverse talent, and something called "buzz"—the desire of ambitious individuals to be where the action is.[3] These superlinear factors can lead to surprising results. For example, one study has found that by simply doubling the population of an urban area, each inhabitant becomes, on average, 15 percent wealthier and 15 percent more productive.[4] Studies have also found, on average, that as a country's urban population rises by 10 percent, the country's per capita output increases by 30 percent.[5]

By 2030, 5 billion people, or two-thirds of the global population, could be middle class

The result is that cities leverage human capital in ways that have an outsized impact on the world's wealth. And in the process, urbanization has created a new, global middle class that is larger, healthier, and wealthier than at any time in history. By 2030, 5 billion people, or two-thirds of the global population, could be middle class.

Members of this dynamic segment can anticipate longer life expectancies, higher levels of innovation and economic activity, improvements in literacy and education, greater access to social services, and better opportunities to participate in political and cultural processes.[6]

They also expect to fly—and in extraordinary numbers.

Less than 20 percent of the world's population has ever flown on an airplane, according to research conducted in 2012. However, a 2013 study of Americans (who comprise a comparatively higher proportion of middle-class consumers) found the inverse of this global metric: less than 20 percent had never flown.[7] Middle-class consumers embrace commercial travel.

These statistics suggest that between now and 2050, growth in commercial aviation will accelerate at an unprecedented rate. The desire of city dwellers to travel for pleasure and explore new cultures will mean new planes, new routes, and new services. Business travelers' demand to access locations all around the world will grow as markets expand. Moreover, the simple desire for a newly mobile workforce to return home periodically to visit their families will create record demand for commercial aviation.

Mobility and connectedness rely on the modern Silk Road, where the miracle of commercial air travel becomes essential to everyday life. Just how essential? That became obvious in April 2010 when ash from Iceland's Eyjafjallajökull volcano closed large parts of European airspace for eight days, and various sectors intermittently for a month. This disruption forced the cancellation of more than 100,000 flights, delaying the travel of 10 million passengers around the world. The airline industry lost $1.7 billion[8]—but this was just the start.

Producers of flowers, seafood and produce in Africa experienced worker layoffs and economic losses, while consumers in European and Asian nations suffered shortages of these same products. Automotive and electronics supply chains were disrupted across two continents. Pharmaceutical companies worried about spoilage of their high-value, lifesaving products. Schools, sporting events, and political activities were cancelled. Travel firms catering to tourism folded. This single, month-long disruption was a stark reminder that commercial aviation is already foundational to trade, tourism, and quality of life for billions of people around the world.[9]

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Forecasts for the global commercial fleet indicate that it must grow quickly to meet the demands of an urbanizing world. In fact, the number of commercial aircraft in service is set to nearly double over the next 15 years – from about 26,000 today to approximately 46,000 by 2030.[10] Meanwhile, 3.5 billion passengers flew in 2015, a number expected to grow 4.8 percent annually through 2033.[11] By then, the industry could serve 6.5 billion passengers, support 103 million jobs, and generate $5.8 billion annually in economic activity.[12]

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Along with moving billions of passengers annually, air transport carries an astonishing 35 percent of the total dollar value of all global trade.[13]

Growth in aviation will put the power of the new middle class on full display. Forecasts for 2033 indicate that two-thirds of the population in emerging countries will take one trip by plane per year. Some 27 percent of all plane trips in the next 20 years will be to visit friends and relatives.[14] Revenue passenger miles—a fundamental measure of the health of commercial aviation—are forecast to increase from about 2 trillion in the year 2000 to nearly 9 trillion in 2030.[15]

And, with a combined 40 percent share of revenue passenger miles, the nations of Asia-Pacific—urbanizing at an accelerating pace—will lead the world in air traffic by then.[16]

A Growing Investment in Aviation

Investment in aviation infrastructure is racing to meet the demands of the flying public. China had 182 airports in 2014. It expects to have 300 by 2030.[17] In Indonesia, Southeast Asia's fastest-growing economy, 13 airports have been listed for expansion and refurbishment.[18] The development of Soekarno-Hatta International Airport in Jakarta is an example of emerging consumer demand; built in 1985 to accommodate 9 million passengers annually,[19] it is today the world's eighth busiest airport, handling more than 62 million passengers annually.[20]

While India has 16 airports designated as international and 454 in total, the government plans to build another 200 low-cost airports to connect its smaller towns and cities.[21] On the eastern Mediterranean, the Queen Alia International Airport in Jordan has adopted a modular design that will accommodate capacity increases from 3.5 million passengers annually to 12 million by 2030.[22] Development at Zagreb International Airport in Croatia includes a new terminal that will welcome 5 million passengers annually, some 2.5 times current capacity.[23]

In the last decade, Middle Eastern hubs have grown faster in terms of passenger demand than any other region in the world.[24] Cairo International Airport, the largest in Egypt and second largest in Africa, is increasing its capacity by 8 million passengers per year, with the goal of accommodating 26 million passengers a year. This growth will support both job creation and tourism.[25] Saudi Arabia has four international airports and 26 domestic or regional airports. The kingdom expects to spend $5.3 billion in the development and refurbishment of its airports over the next 20 years.[26] Hamad International Airport in Qatar opened in 2014 and crossed the 30 million annual passenger mark just two years later. The airport is now being expanded to accommodate 53 million passengers annually by 2020.[27] And Abu Dhabi's International Airport is also expanding through construction of a new terminal that will increase annual passenger capacity from 23 million to 45 million passengers, helping attract new business and tourism.[28]

In Dubai, two projects are slated to quadruple passenger capacity in the next 30 years.[29] Dubai International—already among the world's busiest airports with 75 million annual passengers— recently put the finishing touches

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on a new, $1.2 billion Concourse D that will expand annual passenger capacity at the airport to 90 million.[30] And Dubai's second airport, Al Maktoum International, is in the first phase of a project slated to expand its capacity by 2045 to more than 200 million passengers annually—putting it on pace to become the world's largest airport.

The developed world is also feeling pressure from these new demands for commercial air travel. Heathrow Airport in the London suburbs, the third busiest airport in the world, welcomes 70 million passengers from 193 destinations.[31] However, forecasts suggest that Heathrow, already pushed to 98 percent capacity,[32] will need to handle 320 million passengers in 2030 and 480 million in 2050. Some believe even these estimates are low.[33]

Along with developing new infrastructure, the airline industry is also creating novel business models to accommodate the rising middle class. Lower-cost carriers have carved out a strong position in emerging markets. In Europe, for example, budget operators account for about 40 percent of seat capacity—while in India and Southeast Asia they account for 60 percent.[34]

For middle-class and business travelers around the world, the real cost of air travel has decreased by 60 percent since 1970, making commercial air an affordable and essential part of the professional and personal lives of billions of people.[35]

Aviation and the Sustainable City

Urban growth is not without formidable challenges, however. Sometimes infrastructure is overwhelmed by growth, reducing mobility. A city's inability to provide adequate sanitation, clean water, and nutritious food compromises the health of its residents. Poor planning around land use, building, and commercial development can create joblessness and homelessness.

Cities where growth outstrips infrastructure and economic opportunity develop slums, health crises, pollution, and greenhouse gas.

In 2016, the United Nations adopted a set of goals intended to accelerate sustainable global development.[36] One key objective is to make cities inclusive, safe, and sustainable. Another is to build resilient infrastructure, promote sustainable industrialization, and foster innovation.[37]

Strategies adopted by the U.N. to meet these goals include:

- Providing access to safe, affordable, accessible, and sustainable transport systems
- Reducing environmental impact by focusing on air quality and waste management, and by adopting integrated policies designed to mitigate climate change
- Strengthening regional and trans-border infrastructure
- Helping to expand the commercial fitness and technological capabilities of sister cities—especially in developing, landlocked, and small-island developing countries.[38]

Needless to say, global aviation is uniquely positioned to support these strategies, and to enhance the long-term growth of the earth's sustainable cities. Three aspects of the industry are particularly relevant:

Commercial aviation creates jobs and promotes economic opportunity in every region of the world. This truly global industry supports 58.1 million jobs around the world and 3.4 percent of worldwide GDP. If aviation were its own country it would be about the size of Switzerland, ranking 21st in the world in GDP.

By 2026, aviation is forecast to contribute $1 trillion to world GDP.[39]

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Aviation provides the kind of high-tech, value-added jobs that can lift people from poverty while enhancing urban infrastructure and mobility. In 2012, airports alone invested $19.3 billion in construction, creating employment and enhancing global mobility. On average, aviation jobs are 3.6 times more productive than other jobs, and they improve productivity in other sectors by connecting markets, enabling knowledge transfer, and supporting tourism.[40]

Commercial aviation enhances "air connectivity," strengthening the modern Silk Road. "Air connectivity" is a term defined by the International Civil Aviation Organization (ICAO) to indicate an aviation network's ability to move passengers seamlessly from origin to destination.[41] Improved air connectivity reduces travel times, strengthens business, bolsters human capital, and grows tourism—all essential to the sustainable city.

Sir Peter Hall, who has studied the composition of urban areas from ancient Athens to modern San Francisco, found that vibrant, creative cities are "cosmopolitan, with a diverse mix of peoples and culture, places of intellectual ferment, experimentation, and non-conformity, drawing in free spirits from far and wide."[42] The underlying theme Hall emphasizes is that healthy cities—even with today's instantaneous communication technologies—depend upon mobility and connectedness. Personal contact remains essential in creating and sustaining modern urban areas.

A study of 2,300 business executives conducted by the Harvard Business Review confirms this point.[43] The study showed a broad consensus that in-person meetings are essential to successful long-term relationships. This consensus was especially true when leaders were asked to communicate with colleagues who had different

languages and cultural backgrounds. One executive noted that technology can sometimes meet the needs of face-to-face communications but cannot cover "the side networking, the sidebar meetings and the interaction" that occur before and after the official meeting. Another said that communication via email and phone cannot generate the level of confidence required to move business ahead. A third executive concluded that such communication "cannot deliver the level of confidence and understanding that in-person meetings bring to the table. . . . Face-to-face communications contact is the broadest bandwidth communication you can have in professional life."

Being on the ground in a city is also essential to gauging local and competitive conditions. "There is nothing better than going to the local coffee shop," one respondent said, "or on a walk down the main street to see what is really going on."

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And without face-to-face meetings, creativity suffers. "When we reduce investment in relationship building, we see more friction in interactions between colleagues in different locations," one manager said. "This in turn promotes insular thinking and reduces the possibility of innovation."

The need to widely share new innovations is explicit in the U.N.'s sustainability goals. This prerequisite makes successful technology transfer indispensable, especially in a world where cities in developing countries can make huge advances by leapfrogging legacy technologies.

Technology transfer is a practice heavily dependent on business travel because technological knowledge is described as "tacit." That means it is difficult to convey with simple verbal or written instructions. People tasked with transferring technology may not even be aware of the knowledge they possess or its value to others. Successful technology transfer demands personal contact, regular interaction, and trust.[44] When done well, it can transform distribution, manufacturing capabilities, and partnering solutions. On average, a 10 percent increase in business travel leads to an increase in patenting by about 0.2 percent.[45]

Along with technology and people, a city's enhanced "air connectivity" moves fresh produce to market more quickly, gets medicines and vaccines to locations requiring them, supports just-in-time global manufacturing, and enhances disaster readiness and humanitarian assistance. Commercial airlines also support tourism; 52 percent

of international tourists travel by plane.[46] In fact, a study done for the U.K. Airports Commission revealed that a 10 percent increase in seat capacity could grow tourism dollars within the U.K. by 4 percent, improve U.K. product imports by 1.7 percent and exports by 3.3 percent, and short-term GDP by 1 percent.[47]

One estimate says that the improvements in connectivity from aviation have raised global GDP by $200 billion in the last two decades.[48]

Finally, commercial aviation can contribute directly to the success of cities around the globe in reducing climate emissions, maintaining healthy urban environments, and healing the earth.

International air travel already features aircraft that are 70 percent more efficient and 75 percent quieter[49] than the aircraft of 40 years ago. But the industry has challenged itself to do far better.

In February 2016, a working group of the International Civil Aviation Organization, the United Nations' aviation agency, released a draft of the first-ever binding agreement to cover emissions for aircrafts. If ratified later this year, new efficiency standards will apply to all new commercial jets delivered after 2028.[50]

In parallel, the International Air Transport Association has established goals that include improving fuel efficiency by 1.5 percent annually from 2009 to 2020, capping net aviation carbon dioxide (CO_2) emissions in 2020 (carbon-neutral growth), and reducing net aviation CO_2 emissions by 50 percent by 2050, relative to 2005 levels.[51]

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The 21st century will be marked by vast urban growth. With the rise of cities comes wealth, and with wealth comes a middle class that will demand new goods and services. One of those services already experiencing unprecedented demand is air travel, which must grow rapidly and sustainably over the next generation to meet the needs of people and commerce. By expanding this modern Silk Road, global aviation can promote economic opportunity, provide attractive jobs, and enhance the health and well-being of the cities and regions it serves.

Why do we care? Because healthy, connected cities are, on a per capita basis, *the single most sustainable form of community in which human beings live.*

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"Cities are much more efficient in the consumption of resources," says William Meyer of Colgate University, including the use of land, water, and energy. Compared to rural and suburban areas, urban living spaces are smaller, transportation more efficient, and waste products more easily recycled. And urbanization has the added impact of reducing population growth because city dwellers tend to have "smaller families, but they invest more in each child."[52]

One of the other striking features of the world's emerging middle class is its embrace of sustainability as essential to quality of life. Opinion polls taken of China's new middle class show growing levels of environmental awareness, especially among the more educated and wealthier.[53] This influential segment has environmental knowledge, access to resources, and relationships with the media and officials capable of effecting change. Environmental organizations in China have tackled everything from food scandals and industrial accidents to water and air pollution. And China is already a leader in wind power, and the world's largest solar market.

Top-scoring consumers in National Geographic's 2014 "Greendex"[54] study, designed to measure individual environmental behavior, resided in the developing economies of China and India. In fact, Indian consumers scored first among 17 countries. India's middle class is most likely to minimize the use of fresh water and wash laundry in cold water to save energy. They are also among the most likely to

use solar energy to heat running water. A separate government report found that "environmental and social responsibility are not thought of as transient ideals, but as foundational principles"[55] among Indian citizens.

Universities have also taken up the cause of sustainability, reflecting the needs of this new middle class. The United Nations Educational, Scientific and Cultural Organization (UNESCO) reported that, over the last 20 years, institutions of higher education have introduced new courses related to sustainable development, extended supporting research, and made significant efforts to "green" their own campus operations. More recently, the United Nations Environment Programme (UNEP) created a global partnership that included 370 universities committed to implementing sustainability practices into their curricula.[56]

In short, the children of the world's emerging middle class are being educated in an academic environment unlike anything before, one where sustainability is an integral part of their formal education. This suggests that the next generation of residents along the modern Silk Road will be better prepared to balance economic growth with healthy and sustainable lifestyles.

In a very real way, when global aviation supports healthy urbanization, it also supports a burgeoning middle class working in new, dedicated ways to create a sustainable world.

This suggests that the next generation of residents along the modern Silk Road will be better prepared to balance economic growth with healthy and sustainable lifestyles

UTC and Sustainability

United Technologies Corp. provides technology products and services to the building systems and aerospace industries worldwide. Its Pratt & Whitney segment supplies aircraft engines for commercial, military, business jet, and general aviation markets. The company's UTC Aerospace Systems segment designs, manufactures and services integrated systems and components for the aerospace and defense industries while supporting a global customer base with significant worldwide manufacturing and customer service facilities.

United Technologies has been actively engaged for decades in making urban centers more sustainable places to live and work.

"At our core," says Greg Hayes, President and Chief Executive Officer, "United Technologies is an engineering and manufacturing leader that solves big problems and does big, complex things. Our world is changing, and trends in urbanization and population growth require more sustainable products and behaviors. We're embracing those opportunities across the board."[57]

Of special note, Pratt & Whitney's PurePower® engine with Geared Turbofan™ (GTF) technology – which the company spent $11 billion and 20 years developing – provides customers with 16 percent lower fuel use, a 50 percent overall reduction in regulated emissions, and a 75 percent reduction in overall noise footprint. The fuel savings will cut CO_2 emissions by more than 3,600 metric tons per aircraft per year.[58]

Airbus' delivery to Lufthansa of the first A320neo powered by GTF engines in January 2016 marks a key milestone for commercial air travel and a major advance in providing cleaner, greener and quieter air transport. The GTF engine's environmental benefits are so significant that all of the world's single-aisle airliner manufacturers have either announced new aircraft or are re-engining existing models. As a major contribution to the world's modern Silk Road, Pratt & Whitney's GTF engine family is likely to have the most beneficial environmental and economic impact of any new engine launch in aviation history.

In addition, Pratt & Whitney's Revert Management Program is designed to capture scrap aerospace engine materials and return as much of this material as is feasible to the aerospace industry supply base for reuse. The company is also an active member of the Aircraft Fleet Recycling Association (AFRA), a Boeing-led consortium that strives to recycle aircraft, aircraft components, engine material, and other materials critical to the aerospace industry.[59]

Our world is changing, and trends in urbanization and population growth require more sustainable products and behaviors

1 "Sustainable Urbanization: Thematic Think Piece, UN Habitat," UN System Task Team on the Post-2015 UN Development Agenda, May 2012, http://www.un.org/millenniumgoals/pdf/Think%20Pieces/18_urbanization.pdf.

2 Edward Glaeser, *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier*, New York: The Penguin Press, 2011, 6.

3 Mario Polèse, *The Wealth & Poverty of Regions: Why Cities Matter,* Chicago: The University of Chicago Press, 2009, 33-48.

4 N.L., "The City Triumphs, Again," *The Economist,* June 6, 2013, http://www.economist.com/blogs/babbage/2013/06/urbanisation.

5 Edward Glaeser, *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier,* New York: The Penguin Press, 2011, 7.

6 "World Urbanization Prospects: The 2014 Revision, Highlights," Department of Economic and Social Affairs, United Nations, New York, 2014, http://esa.un.org/unpd/wup/highlights/wup2014-highlights.pdf.

7 Eighteen percent of Americans had never flown. See Christine Negroni, "How Much of the World's Population Has Flown in an Airplane?", *Air & Space Magazine,* January 6, 2016, http://www.airspacemag.com/daily-planet/how-much-worlds-population-has-flown-airplane-180957719/. Also see https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/omnistats/volume_03_issue_03/pdf/entire.pdf.

8, 9 "Sustainable Aviation," Airbus, 2013, file:///C:/Users/Eric%20B%20Schultz/Downloads/Airbus-Aviation_Roadmap_Brochure_Jun13.pdf. See also "Effects of the April 2010 Eyjafjallajökull Eruption," Wikipedia, accessed 2016, https://en.wikipedia.org/wiki/Effects_of_the_April_2010_Eyjafjallaj%C3%B6kull_eruption.

10 "The Airline Monitor: A Review of the Trends in the Airline and Commercial Jet Aircraft Industries." February 2016.

11 "Forecast for Global Aviation," *Radical Departures,* Makino, 2016, https://www.radical-departures.net/articles/aircraft-market-forecast/default.aspx?mobile=1.

12, 13 "Aviation Benefits Beyond Borders," ATAG, April 2014, http://aviationbenefits.org/media/26786/ATAG__AviationBenefits2014_FULL_LowRes.pdf.

14 "Forecast for Global Aviation," *Radical Departures,* Makino, 2016, https://www.radical-departures.net/articles/aircraft-market-forecast/default.aspx?mobile=1.

15 "The Airline Monitor: A Review of the Trends in the Airline and Commercial Jet Aircraft Industries." February 2016.

16 "Forecast for Global Aviation," *Radical Departures,* Makino, 2016, https://www.radical-departures.net/articles/aircraft-market-forecast/default.aspx?mobile=1.

17, 18 "Connectivity and Growth: Directions of Travel for Airport Investments," PWC, November 2014, https://www.pwc.com/gx/en/capital-projects-infrastructure/publications/assets/pwc-connectivity-growth.pdf.

19 "Soekarno–Hatta International Airport, *Wikipedia*, accessed June 2016, https://en.wikipedia.org/wiki/Soekarno%E2%80%93Hatta_International_Airport.

20 Jakarta's Soekarno-Hatta International Airport World's 8th Busiest Airport," February 22, 2014, http://www.indonesia-investments.com/business/business-columns/jakarta-s-soekarno-hatta-international-airport-world-s-8th-busiest-airport/item1674.

21 "Connectivity and Growth: Directions of Travel for Airport Investments," PWC, November 2014, https://www.pwc.com/gx/en/capital-projects-infrastructure/publications/assets/pwc-connectivity-growth.pdf.

22 "Queen Alia International Airport, Jordan," International Finance Corporation," World Bank Group, accessed 2016, http://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/industries/infrastructure/transportation/tp_casestudies/queen+alia+international+airport,+jordan.

23 "Government Confirms New Zagreb Airport Name," *CroatiaWeek,* February 25, 2016, http://www.croatiaweek.com/government-confirms-new-zagreb-airport-name/. See also "Zagreb International Airport, Croatia," International Finance Corporation, World Bank Group, accessed 2016, http://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/industries/infrastructure/transportation/tp_casestudies/zagreb+international+airport,+croatia.

24 "Connectivity and Growth: Directions of Travel for Airport Investments," PWC, November 2014, https://www.pwc.com/gx/en/capital-projects-infrastructure/publications/assets/pwc-connectivity-growth.pdf.

25 "Egypt: Cairo's Terminal 2 Preparing to Increase its Capacity by 8 Million Passengers," The World Bank, December 17, 2015, http://www.worldbank.org/en/news/feature/2015/12/17/egypt-cairos-terminal-2-preparing-to-increase-its-capacity-by-8-million-passengers.

26 "Connectivity and Growth: Directions of Travel for Airport Investments," PWC, November 2014, https://www.pwc.com/gx/en/capital-projects-infrastructure/publications/assets/pwc-connectivity-growth.pdf.

27 Shabina S. Khatri, "Skytrax Names Qatar's Hamad Int'l Best Airport in Middle East," DOHA News, March 17, 2016, http://dohanews.co/skytrax-names-qatars-hamad-intl-best-airport-middle-east/.

29 Shareen L. Gazzar, "Abu Dhabi Airport Expects 10% Passenger Growth This Year as Midfield Terminal Nears Completion," *The National,* March 8, 2016, http://www.thenational.ae/business/aviation/abu-dhabi-airport-expects-10-passenger-growth-this-year-as-midfield-terminal-nears-completion.

28 Current estimates show Dubai International at a 75 million annual passenger capacity and Al Maktoum at 7 million. Estimates are for Dubai International to grow to 90 million and All Maktoum to as much as 260 million by 2045, a total increase of 4.3 times. See "UAE- ENOC to Begin Construction of Project Falcon Extension to Al Maktoum International Airport," Emirates News Agency, March 17, 2016, http://www.menafn.com/1094651630/UAE--ENOC-to-begin-construction-of-Project-Falcon-extension-to-Al-Maktoum-International-Airport and Adam Schreck, "Dubai's Bold Plan to Build the World's Biggest Airport," *USA Today,* September 10, 2014, http://www.usatoday.com/story/todayinthesky/2014/09/10/dubais-bold-plan-to-build-the-worlds-biggest-airport/15376795/.

30 "New Dubai International Terminal Welcomes First Flight," *Gulf News,* February 25, 2016, http://gulfnews.com/news/uae/transport/new-dubai-international-terminal-welcomes-first-flight-1.1679226.

31 "Flight Paths for a Cloudy Future," *The Economist,* March 30, 2013, http://www.economist.com/news/briefing/21574489-britain-has-many-options-providing-extra-airport-capacity-its-capital-going-need.

32 C.R., "Do Hub Airports Boost Growth?," *The Economist,* December 1, 2015, http://www.economist.com/blogs/gulliver/2015/12/economics-aviation-capacity.

33 "Flight Paths for a Cloudy Future," *The Economist,* March 30, 2013, http://www.economist.com/news/briefing/21574489-britain-has-many-options-providing-extra-airport-capacity-its-capital-going-need.

34 "A Smoother Ride: Why Airbus and Boeing Have Less to Fear Than Before From the Aviation Cycle," *The Economist,* January 16, 2016, http://www.economist.com/news/business/21688392-why-airbus-and-boeing-have-less-fear-aviation-cycle-smoother-ride.

[35] "Aviation Benefits Beyond Borders," ATAG, April 2014, http://aviationbenefits.org/media/26786/ATAG__AviationBenefits2014_FULL_LowRes.pdf.

[36, 37, 38] "Follow-up to the Outcome of the Millennium Summit Draft Resolution Submitted by the President of the General Assembly, Draft Outcome Document of the United Nations Summit for the Adoption of the Post-2015 Development Agenda," United Nations, August 12, 2015, http://www.un.org/ga/search/view_doc.asp?symbol=A/69/L.85&Lang=E.

[39, 40] "Aviation Benefits Beyond Borders," ATAG, April 2014, http://aviationbenefits.org/media/26786/ATAG__AviationBenefits2014_FULL_LowRes.pdf.

[41] "Connectivity and Growth: Directions of Travel for Airport Investments," PWC, November 2014, https://www.pwc.com/gx/en/capital-projects-infrastructure/publications/assets/pwc-connectivity-growth.pdf.

[42] Mario Polèse, *The Wealth & Poverty of Regions: Why Cities Matter,* Chicago: The University of Chicago Press, 2009, 8.

[43] "Managing Across Distance in Today's Economic Climate: The Value of Face-to-Face Communication," A Report by Harvard Business Review Analytic Services, sponsored by British Airways, *Harvard Business Review,* 2009, https://hbr.org/resources/pdfs/comm/british-airways/hbras_ba_report_web.pdf.

[44] "Tacit Knowledge," Wikipedia, accessed 2016, https://en.wikipedia.org/wiki/Tacit_knowledge.

[45] Nune Hovhannisyan and Wolfgang Keller, "International Business Travel: An Engine of Innovation?," NBER Working Paper No. 17100, May 2011, http://www.nber.org/papers/w17100.

[46] "Aviation Benefits Beyond Borders," ATAG, April 2014, http://aviationbenefits.org/media/26786/ATAG__AviationBenefits2014_FULL_LowRes.pdf.

[47] "Connectivity and Growth: Directions of Travel for Airport Investments," PWC, November 2014, https://www.pwc.com/gx/en/capital-projects-infrastructure/publications/assets/pwc-connectivity-growth.pdf.

[48] "Aviation Benefits Beyond Borders," ATAG, April 2014, http://aviationbenefits.org/media/26786/ATAG__AviationBenefits2014_FULL_LowRes.pdf.

[49] "Global Aviation and Our Sustainable Future," International Civil Aviation Organization Briefing for RIO+20, 2012, http://www.icao.int/environmental-protection/Documents/Rio+20_booklet.pdf.

[50] Jad Mouawad, "Deal on Aviation Emissions Sets Can't-Miss Goals," *The New York Times,* February 15, 2016, http://www.nytimes.com/2016/02/16/business/energy-environment/a-hollow-agreement-on-aviation-emissions.html.

[51] Greg Gernhardt, "Pratt's View: A New Era in Air Travel," AviationWeek.com, January 20, 2016, http://aviationweek.com/commercial-aviation/pratt-s-view-new-era-air-travel.

[52] Steven Cherry, "Want to Save the Environment? Build More Cities," Spectrum.ieee, May 7, 2013, http://spectrum.ieee.org/podcast/energy/environment/want-to-save-the-environment-build-more-cities.

[53] Arthur Mol, "China's Middle Class as Environmental Frontier," January 11, 2012, *Al Jazeera,* http://www.aljazeera.com/indepth/opinion/2012/01/201217122143498595.html.

[54] "Greendex 2014: Consumer Choice and the Environment – A Worldwide Tracking Survey HIGHLIGHTS REPORT," *National Geographic,* September 2014, http://images.nationalgeographic.com/wpf/media-content/file/NGS_2014_Greendex_Highlights_FINAL-cb1411689730.pdf.

[55] "India Consumers and Sustainability," *PR Newswire,* December 7, 2015, http://www.prnewswire.com/news-releases/india-consumers-and-sustainability-2014-300189019.html.

[56] Goolam Mohamedbhai, "What Role For Higher Education In Sustainable Development?", *University World News,* January 9, 2015, http://www.universityworldnews.com/article.php?story=20150108194231213.

[57] "New United Technologies Goals Advance Sustainable Urbanization," United Technologies, accessed 2016, http://www.utc.com/News/News-Center/Pages/New-United-Technologies-Goals-Advance-Sustainable-Urbanization.aspx.

[58] Greg Gernhardt, "Pratt's View: A New Era in Air Travel," AviationWeek.com, January 20, 2016, http://aviationweek.com/commercial-aviation/pratt-s-view-new-era-air-travel.

[59] 2016 United Technologies Corporation—Pratt & Whitney Division, 2016, http://www.pw.utc.com/Environmental_Leadership.

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The PurePower Geared Turbofan engine family has about 7,000 orders and commitments, including options, for five different aircraft platforms. In this role, Gernhardt is also responsible for overseeing Pratt & Whitney's interest in IAE International Aero Engines AG (IAE) and the Engine Alliance (EA).

Gernhardt joined Pratt & Whitney in 1990 and has held a number of engineering, program management, sales, business development and customer service roles of increasing responsibility, including a leadership role at International Aero Engines (IAE).

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Pratt & Whitney is a world leader in the design, manufacture and service of aircraft engines and auxiliary power units. United Technologies Corp., based in Farmington, Connecticut, provides high-technology systems and services to the building and aerospace industries. To learn more about UTC, visit the website at www.utc.com or follow the company on Twitter: @UTC.

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John Mandyck serves as Chief Sustainability Officer for United Technologies Corporation. A global leader in the aerospace, food refrigeration and commercial building industries, United Technologies provides high-technology systems and services that move the world forward with well-known global brands such as Carrier, Otis, Pratt & Whitney and UTC Aerospace Systems.

John chairs the Corporate Advisory Board of the World Green Building Council, and serves as chairman of the Board of Directors for the Urban Green Council in New York City. He is a member of the Corporate Council at the Harvard University Center for Health and the Global Environment. He is also on the adjunct faculty for the University of Connecticut School of Business. John is the co-author of the book *Food Foolish*, which explores the hidden connection between food waste, hunger and climate change.

Throughout his career, John has worked with governments, universities and organizations around the globe to accelerate environmental sustainability in an increasingly urbanizing world. He blogs on sustainability issues at SustainabilityView.com and can be found on Twitter @JohnMandyck.