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Volume 20 Number 2 2019/pp.83-114 www.usask.ca/esteyjournal

The Estey

Journal of International Law and Trade Policy

Megatrends Affecting Air Transport — Connecting the Dots

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Abstract

The air transport world is fast moving toward an evidence- and data-based approach with a view to facing the forces that drive our existential lives. Called megatrends, these forces portend a world that will be riven by the rapid evolution of current trends that leaders of the aviation world will have to contend with over the next 25 to 30 years. These trends are already among us and will evolve in significance. In the context of the aviation industry a reckonable fact is that by 2020 the global middle class will number 3 billion people, and the aviation industry will be able to connect with them all through the smart devices in their pockets. By 2020, 21 billion network devices will be in use – up from 2 billion just a decade ago. Mobile technology, cloud computing, data analytics, biotech and genomics, and artificial intelligence are all advancing rapidly. Consequently, one can expect growth opportunities related to aircraft digitization and new high-performance materials, as well as hybrid engines and 3-D printing. As this article discusses, although information technology is one of the most pervasive megatrends, others such as the shift of global trends, demographic change, climate change, and other trends and drivers are intertwined. This article discusses the megatrends in their various linkages and argues that law and regulation are key elements in managing these trends and ensuring that whatever the buzzwords might be in modern usage and however much they would facilitate the functioning of a rapidly changing world, they must be properly regulated.

Keywords: artificial intelligence, aviation; climate change, connectivity, demography, geo-politics, ICAO, information technology, megatrends

1. Introduction

Any megatrend is a global direction towards which a large transformative force drives the entire world. It is not sectarian, affecting merely a part of the world, region, or country. Megatrends affect our existential life and connect everything: data, processes, humans, and geo-political instability. Thus, megatrends represent an important shift in the progress of a society. The current megatrends are the global economic shift from the West to the East; increasing urbanization; demographic changes; innovative technology; climate change; and global connectivity.

Megatrends emerge through what are called "drivers", such as globalization; competition; digitalization; decreasing lifestyle satisfaction; terrorism; entrepreneurial mindset; geo-political challenges; emergence of alternative lifestyles; increasing energy demands; wearables (smart phones et al.); drones; augmented and virtual reality; blockchain and cryptocurrencies; 3D printing; biotechnology; robotics; cyber deceit; and sustainability (which is the key driver of innovation). These drivers are often wrongly regarded as megatrends, which they are not.

The drivers of megatrends are influencers promoting global transformative forces that change the course of society. Taking the megatrends in the order mentioned above, the drivers of the global economic shift from the West to the East are geo-politics; global income inequality; volatility and weakness of the global economy; the changing industry supply chain; the shift to a knowledge-based economy; privatization; data transparency; and the changing nature of work and the future of work. In the case of rapid urbanization, the drivers are global ageing; growth of the middle class in Asia; consumption; population evolution; growth of mega cities; shifting ethnic identities; and innovations in medical technology. Demography is influenced by changing patterns in employment; focus on technology; social values; geo-political instability; strength of governance; and increasing influence of alternative regional and global institutions. Each of these megatrends is directly impacted by the drivers of megatrends and by the megatrends themselves.

Megatrends must be approached in a manner that recognizes them as parts of a system, because each megatrend affects the others. This approach would essentially require systemic leadership, which in turn calls for system initiatives. These system-level initiatives should be constructed on the premise that a contextual understanding of how a complex system interacts is required to achieve sustainable change in a positive manner that affects our existential lives.

Megatrends directly impact the work of the International Civil Aviation Organization (ICAO) – the specialized agency of the United Nations that addresses

international civil aviation. The Council of ICAO has adopted five strategic objectives: *Safety* (enhance global safety); *Air Navigation Capacity and Efficiency* (increase the capacity and improve the efficiency of the global civil aviation system); *Security & Facilitation* (enhance global civil aviation security and facilitation); *Economic Development of Air Transport* (foster the development of a sound and economically viable civil aviation system); and *Environmental Protection* (minimize the adverse environmental effects of civil aviation activities). These strategic objectives are oriented towards the ICAO's vision, which is to achieve sustainable growth of the global civil aviation system.

Air transport evolves rapidly and grows exponentially. Inevitably, challenges faced by the industry change almost every decade. These changes are influenced by megatrends and their drivers, and leaders must adapt their business strategies. There have been numerous changes over the past three decades. Over the past 30 years the airline industry has seen the advent of low-cost carriers (LCCs), which have obtained sizeable market shares, and natural disasters such as volcanoes and the spread of infectious diseases. The next 30 years are likely to be more turbulent, calling for new approaches in leadership and entrepreneurship.

There is one incontrovertible fact: the future of the world, as affected by megatrends, will be integrally connected with the world of business. The world of business will be of service only to innovative leaders who find new solutions to existing problems. One example of innovation in business practice is the paradigm shift from adapting global products to the needs of local markets to innovating locally to suit the demands of global markets. Another is branding unbranded products and markets. Yet another innovative business practice is disruptive innovation.

A good example of disruptive innovation is a measure – the third wave – that caters to the new demography of millennials, who are known as the "gypsy tribe" because of their frequent and far-ranging travel. Millennials are highly tech savvy 25-35-year-olds who seek the best possible and easiest way to their point-to-point destinations. The approach taken by the Boeing Dreamliner in creating an aircraft that is best suited to meet this need and therefore able to capture this market is a case in point. Another characteristic of millennials is that they are integrally linked to innovative technology. This is where megatrends converge as parts of a system. The first step for airlines seeking to cash in on disruptive innovation with the millennial market is be to be ready with apps and connecting tools that can boast of having the internet of things involved in the product they offer this new market. The third wave could disrupt every competitor unless they meet the expectations of the millennials. One of the key strategies in the internet of everything is forming partnerships with the "connectors". For instance, an

airline that wins the new market of millennials would have to be in partnership with the providers of up-to-date in-flight entertainment systems.

This discussion illustrates the compelling need for airlines to think systemically so that all the dots are connected in the internet of everything. The interconnection of all elements that make the air transport product attractive to the millennial would require looking at parallel scenarios; being flexible enough to adapt to changing trends; a certain amount of risk taking; and seeking new partnerships.

2. The Global Economy

Although in 2017 the global economy showed the best growth performance in six years, amidst contrasts in various regions of the world – from growth acceleration to concern and anxiety wrought by political dissent and fragmentation, as well as polarization and tension between the major economies – the global economy slumped in 2018, slowing trade and business confidence. The global economy in 2018 was expected to grow at 3.2 percent, matching 2017's growth rate, and well above 2016's 2.5 percent. The emergent truth in 2017 was that socio-political forces had a deep influence on the global economy centrifugally, resonating from core trade and economic philosophy to the outside world. These forces were key drivers of the shift that is occurring from the West to the East. Markets and economies withstood these forces with robust flexibility, obviating political disorder as an influencing factor to overall growth. The International Monetary Fund has forecast a modest 3.7 percent worldwide growth for 2019.[2]

A key deviation and economic setback that flowed into 2018 and continued into 2019 was Brexit in the United Kingdom, which not only presented the possibility of an economic disadvantage both to the United Kingdom and the other members of the European Union, but also threatened to create a power imbalance in Europe. Although the United Kingdom government went on the assumption that the referendum result was sufficient to trigger Article 50[3] of the Lisbon Treaty,[4] the Supreme Court of the UK disagreed, stating that parliamentary authority must be obtained by the Prime Minister to trigger the provision, after which formal notice of Brexit to the EU could be given. On 8 February 2017, this requirement was complied with through an absolute majority in Parliament. The next step was to obtain assent of the second chamber of the bicameral process in the UK – the House of Lords – assent that was accomplished subsequently. Article 50 notification was received by the EU in March 2017, and there was provision for a two-year period from that year until formal exit of the UK would take place.

During the two-year period, and at the time of writing, exit terms were being discussed in the United Kingdom Parliament after a deal struck between the prime minister and Europe had been rejected by the House. For her part, initially, the prime

minister of the UK submitted 12 principles that indicated a framework for negotiation with the EU. The 12 principles were discussed during the interim two-year period with a view to reaching a meaningful agreement between the parties that would obviate ambivalence regarding the positions of the parties. Meanwhile, the UK airlines would have to await results of the negotiations, which could pose difficulties in their planning for the future.

From an air transport perspective, a major effect that Brexit would have will be on the US-EU Open Skies Agreement,[5] which would no longer apply to UK carriers when the UK separates from the EU. The "Community Carrier" status of the British carriers could be removed. Should this happen, the UK may have to revert to the *status quo* existing prior to the UK joining the EU. It is reported that the EU is the single largest air transport market for the UK carriers, involving 49 percent of passenger traffic, and 54 percent of scheduled carriage of UK carriers being within the EU.[6] These figures could change with Brexit, where the UK would have to negotiate separate bilateral air services agreements with the rest of the EU member states. It would follow that under the new circumstances, unless granted within the Brexit negotiations, the UK carriers will lose their inherent right to market access on an intra-Europe basis between cities within the same EU member state (e.g., Paris/Nice) or between two cities in two different EU member states (e.g., Lisbon/Rome).

An IATA study[7] released in October 2018 states that in the context of the new US-UK relationship after Brexit both the United Kingdom and the United States have shown some willingness to replicate the current EU-US agreement wherein any reference to the EU the acronym "EU" will be replaced by "UK". However, consequences for the UK will be different, for example in the ownership and control requirement in the bilateral air services agreement between the US and the UK. The IATA study states that "[T]his would mean that UK carriers operating a transatlantic route would need to be 'substantially owned and effectively controlled' in the UK specifically, not across the EU as a whole, even if an EU-UK agreement on reciprocal ownership were in place. Airlines would therefore have to choose between concentrating ownership and operating licences in the EU to allow operation under the EU-US agreement or make substantial (and potentially costly) changes to ownership structure to consolidate ownership in the UK."[8]

As for intra-European air traffic, the European Commission expects significant challenges and disruptions from a hard Brexit without a compromise deal between the UK and the EU. Accordingly, as this article was written, the EU was preparing contingency plans that would mitigate the consequences of a hard Brexit. The contingency plan aims at maintaining basic services that would cater to the travelling

public of member countries of Europe without a guarantee of the *status quo ante* that would have existed before Brexit. The European Commission, which is formally charged with the issue of market access within the EU has stated,

> UK carriers will be allowed to make a technical stop in the EU or fly over the EU, though they will lose their current right to operate freely within the EU – between member countries and domestically in member countries. Their traffic rights to the EU will be restricted to third and fourth freedom; in other words, they will be allowed to operate between any point in the UK and any point in the EU. In addition, their capacity will be restricted. According to the proposed regulation, the total seasonal capacity to be provided by UK air carriers for routes between the UK and each member state shall not exceed the total number of frequencies operated by those carriers on those routes during respectively the IATA winter and summer seasons of the year of 2018.[9]

This would mean that the number of frequencies to be operated by UK carriers would be "frozen" at pre-Brexit levels, and the pre-existing flexibility given to UK carriers in the area of cooperative marketing arrangements, leasing of aircraft, and change of gauge would have to be renegotiated.[10]

3. Scope of Air Transport

ICAO recorded that in 2015, 3.5 billion passengers were carried.[11] The organization's World Civilian Aviation Report goes on to say that the key driver of future air transport growth will be sustained world economic and trade growth as well as declining airline costs and ticket prices. ICAO said that in 2017 an unprecedented 4.1 billion passengers were carried by the aviation industry on scheduled services. This represented a 7.1 percent increase over 2016. The number of departures rose to approximately 37 million globally, and world passenger traffic, expressed in terms of total scheduled revenue passenger kilometres (RPKs), posted an increase of 7.6 percent with approximately 7.7 trillion RPKs performed. This growth is a slight improvement from the 7.4 percent achieved in 2016.[12]

As for air cargo, the same report records that cargo traffic experienced an annual growth of 1.7 percent in 2015 in terms of freight tonne kilometres, reflecting a substantial slowing as compared to a 4.7 percent increase in 2014. The outlook for 2042 is an overall 4.5 percent growth rate. Boeing, in its World Air Cargo Forecast 2016-2017 says,

> [W]orld air cargo traffic has struggled to maintain sustained growth since the end of the global economic downturn in 2008 and 2009. After bouncing back in 2010, then stagnating in 2011 and 2012, air cargo began growing again in mid-2013, even growing 4.8% in 2014, a year in which US$6.4 trillion worth of goods were carried by air. Growth accelerated in the first

> quarter of 2015, but then traffic volumes remained flat for the rest of that year. Air cargo traffic gathered some strength after a weak first quarter of 2016 and is projected to return to trend growth by 2018. Despite the weak growth of the past decade, more than one-half of air cargo is still carried on freighters.[13]

The Air Transport Action Group – an arm of the International Air Transport Association (IATA) – in its report states that the global aviation industry's total economic impact – encompassing direct, indirect, induced, and tourism-related – reached US$2.7 trillion, which amounts to 3.5 percent of the world's gross domestic product.[14] The same report states that the air transport industry in 2014 supported 62.7 million jobs globally, while 9.9 million of this total were jobs directly ascribed to the airline industry.

It has been predicted that by the year 2020, air travel would have doubled compared to today's figures. ICAO expects that global passenger traffic will grow at a rate of 4.6 percent annually to 2032.[15] A global market forecast by Airbus Industrie states that between 2009 and 2028 there will be a demand for 24,951 passenger and freighter aircraft worth US$3.1 trillion and that by 2028 there will be 32,000 aircraft in service compared with 15,750 in 2009.[16] In January 2015, ongoing projects for airport construction amounted to the value of US$543 billion globally. These facts and figures incontrovertibly spell out the future of air transport and the inevitable fact that liberalization of air transport and the use of more efficient operating systems for air navigation, airport operations, and marketing are compelling needs to meet demand.

Air transport and tourism are intrinsically linked, and it is estimated that over 54 percent of tourists travel by air. Air transport offers a unique connectivity for tourists to get to their destination, which is why it is the largest single transportation mode for tourists. Travel and tourism's direct contribution to global GDP is expected to grow at an average rate of 3.9 percent per year over the next ten years. The World Travel and Tourism Council (WTTC) has said that by 2027, travel and tourism is expected to support more than 380 million jobs globally, which equates to one in nine of all jobs in the world, and the sector is expected to contribute around 23 percent of total global net job creation over the next decade. Meanwhile, total travel and tourism GDP is expected to account for 11.4 percent of global GDP, and global visitor exports are expected to account for 7.1 percent of total global exports.

The World Tourism Organization (UNWTO) in its 2016 annual report states that 2016 was a memorable year for tourism, as international tourist arrivals continued their upward trajectory in their seventh straight year of above-average growth despite many challenges, reaching 1.2 billion. Fast forward to 2019, and UNWTO says that there were 1.4 billion international tourist arrivals (+6 percent) in 2018, showing a robust trend

which added to the strong figures of 2017 and was second only to the large numbers shown in 2010. For 2019, UNWTO's forecast is a 3-4 percent increase, in line with the historical growth trend and exponential increase that is portended.[17]

Despite this sanguine vision, air transport faces certain restrictions. It is the only mode of transport which can operate commercially subject to the permission of or authorization from the country to which aircraft offering air transport services fly; foreign direct investment in air carriers is often restricted by states; and the majority of ownership and effective control of an airline should be with nationals of the state in which the airline is established. The symbiosis of air transport and tourism and their exponential growth call for liberalization of air transport as a trading process.

Against this scenario, megatrends, in their own way, affect air transport where managers have to deduce who their clients and customers will be in the next 20 years and what routes the millennials would prefer.

Two goals must be accomplished if the air transport industry is to be recognized as a major contributor to the world economy and trading process and assisted accordingly. The first is to treat air transport as a trading tool and not as a luxury. A liberalized trading process must be applied in the context of air transport. It is incontrovertible that liberalization of air transport is a global trend that is irreversible and has been ongoing since the eighties. In the liberalization process, fluctuations of global economic factors and their effect on the role of, and national approaches to, market access continue to be the most critical elements in air services agreements between states. These factors remain integral to substantive regulatory liberalization should a state decide to radically alter its stance toward opening the skies. In considering liberalization of market access, states invariably face two basic issues: the extent of liberalization, i.e., how open the market access should be in terms of the grant of traffic rights; and the approach to liberalization, i.e., whether liberalization should be national, bilateral, regional, plurilateral, or multilateral and the pace at which liberalization should be pursued. The second goal is to remove political influence on commercial air transport.

4. Innovative Technology

There are two key styles of leadership that could effectively deal with megatrends: insight leadership and systems leadership. These styles are not mutually exclusive but are symbiotic. The factors that bind the two approaches are innovative technology, multiple data sources, and analytics. Insights are essential to product development in the age of megatrends. Systems leadership is based on abdicating tired business practices and in their place embracing the global changes that are taking place as a system. Keyed into this approach are digitalization, disruptive innovation (creating new

markets for existing products), and sensitivity to rapidly evolving customer expectations. In the air transport industry, leadership will depend significantly on innovative technology, in particular on artificial intelligence (AI).

AI systems are proliferating rapidly. They are made available by companies through the *Cloud*. The significance of AI to air transport lies in the fact that issues in air transport inevitably attenuate both qualitative and quantitative data. In the realm of accident investigation as well as breaches of aviation security, traditional approaches often cannot be used or modelled, and therefore Big Data and Deep Learning could be of considerable assistance. The human factor in air transport has been seen to optimize the challenge in emergency situations, which renders traditional mathematical programming destitute of effect.

It is estimated that there are currently more than 1,700 AI start-ups with over $14.6 billion in total funding from 70 different countries. Revenues from AI applications are expected to reach $47 billion by 2020, up from $8.0 billion in 2016.[18] There is growing concern that the jobs of 63 million aviation workers could be at risk when AI ultimately replaces human resources in aviation.[19]

SITA[20] has recorded that both airlines and airports are attracted to AI and the technologies that come with it in the context of service quality and customer service. Heavy investment has been planned until 2020 by airports on research and development (45 percent of all airports), whereas 52 percent of global airlines are currently using AI technology and programmes. Airlines are particularly interested in using AI to minimize disruption of service to their customers and enhance their warning systems.[21]

Artificial intelligence has been applied to air traffic control with some success, and AI has been developed at the Lincoln Laboratory which has automated basic air traffic functions. However, it has been recognized that general planning with AI does not easily rest with air traffic control. An article published in the *Lincoln Laboratory Journal* says, "One difficulty in applying this method to ATC problems is that in ATC there exist no particular end states that need to be achieved. That is, in general many possible future situations are acceptable. Another difficulty is that the use of logical assertions does not capture the continuous behavior of physical systems such as aircraft in flight, and it also introduces a number of artificial logical problems to the system."[22]

In other words, considering the large number of decisions to be taken and actions to be carried out in the process of providing air traffic control for the safe navigation of aircraft, which involves the consideration of numerous factors such as the presence of other aircraft in the vicinity; severe weather conditions; simultaneous communications between multiple controllers in different segments of airspace; the impossibility of directing an aircraft to climb further than the maximum altitude already reached; and

the coordination of timing with the speed of ascent or descent, these factors could all be beyond the cognitive capacity of AI.

There are two fundamental principles applicable to both insight leadership and systems leadership regarding the use of AI. The application of AI to air transport should be based on the highest values of human rights and must not intrude on the contemporary aspirations of people living in the 21st century. The World Conference on Human Rights held in Vienna in 1993 recognized and affirmed that all human rights derive from the dignity and worth inherent in the human person, and that the human person is the central subject of human rights and fundamental freedoms, and consequently should be the principal beneficiary and should participate actively in the realization of these rights and freedoms.

The conference also reaffirmed the solemn commitment of all states to fulfil their obligations to promote universal respect for, and observance and protection of, all human rights and fundamental freedoms for all in accordance with the Charter of the United Nations, other instruments relating to human rights, and international law, stating that the universal nature of these rights and freedoms is beyond question.

The second moral principle is that AI should result in optimal benefit to humankind. This benefit should be measurable both in scientific and economic terms. This would largely hinge on governance and the way AI is applied to assist the consumer whilst not eroding rights of privacy, life, and liberty. There should also be a clear legal and regulatory regime that would identify responsibility and accountability of those applying AI to air transport. A follow-up to responsibility and accountability should be the sensitivity of AI to a clear retrospective understanding of the way AI worked when something went wrong with the AI application used. Until these various issues become clearer AI should be used as a mathematical and scientific tool that provides extended intelligence to humankind.

With these principles in mind, AI could affect air transport in areas such as passenger experience, flight operations, security on board aircraft, as well as overall safety. One of the key areas would be the way in which passenger data is used and stored with more efficiency and protection. Protection of aircraft on runways as well as in vertical separation and accident prevention would be key areas where AI would assist air transport. Furthermore, an entire passenger journey could be made more efficient from check-in through security (with biometric identification) and thereafter the journey to the gate, where beacons could guide the passenger through various venues that he needs to visit prior to boarding as well as with flight information display systems.

Innovative Technology is driven by expanding human intelligence; robotics and automation; virtual and augmented reality; cybersecurity; new technical designs; and

the internet of things. *Climate Change* is driven by regulations on emissions; alternative fuels and renewable energy sources; carbon trading; extreme weather; water and food supply; and rising sea levels. *Global Connectivity* is driven by competition; trade practices; travel patterns of new markets; airline policies as set by various governing bodies; rising population; technological progress; increased productivity; and globalization.

Innovative technology as a megatrend has as its root the extension of human intelligence to create digital intelligence as a mental, physical, and social extension of persons. An example of this is our association with the internet as well as the internet of things, where the latter digitally links inanimate objects, enabling them to talk to one another. Artificial intelligence and Big Data are two other drivers, along with 3D printing, which uses digitally transmitted parameters to create physical objects. Innovative technology enables us to conduct business more effectively, facilitate globalization, and enhance social discourse. Digitalization also enables sustainability of the business and social world. However, the issue is whether the new innovations that monitor worker performance in terms of speed of productivity at the assembly line, or the distance travelled by a worker to report to duty, could affect corporate social responsibility that is expected to ensure the worker gets a fair deal from the employer. Another issue is whether there could be confirmation bias that could mislead the company into discontinuing the services of a worker who is subjected to confirmation bias and whose only source of income that supports their school-going children is their wage.

Innovative technology also comes with its challenges both to businesses as well as their consumers. A survey carried out by PricewaterhouseCoopers (PwC) reflected that 60 percent of CEOs were concerned that the exponential advancement of innovative technology would affect their companies' growth. As for the consumer, digital technology acts as a prompt to expect personalised solutions to their problems.

The march of innovative technology into business is an incontrovertible fact. There is also no room for doubt that innovative technology has ensured connectivity and networking through billions of devices. This has been accomplished through cloud computing and miniaturising of communications chips and sensors. The internet of things could add trillions of dollars to the global GDP within the next few years. It ensures enhanced customer service and satisfaction as revenue. Cloud computing, when used in business practices, offers a more managed enterprise governance model. Of importance to this discussion is the nature of artificial intelligence. The term "artificial intelligence" has been challenged as connoting emotional intelligence that humans possess; however, scientists cannot even imagine a time when computers would acquire

emotional intelligence. IBM advocates terms such as "cognitive computing" or "augmented intelligence" to describe what is popularly known as AI for this reason. In this context, AI forms two broad categories: knowledge-based intelligence delivered by knowledge-based systems (KBS) and computational intelligence which involves neural networks, fuzzy systems, and evolutionary computing. The former is applied based on the reliance placed on information provided by a human (such as rules and algorithms), while the latter delivers through networks of computational systems. Air transport involves the use of qualitative and quantitative data but is primarily governed by human involvement, whether in maintenance, air traffic control, or flight deck management. This factor makes it difficult to rely entirely upon mathematical computations or nonemotive reasoning in air transport.

Blockchain is a technology which can affect air transport in many ways. Although blockchain came into being with bitcoin as a cryptocurrency, its utility as a multilayered records system could be of immense use to air transport in the future. One of the examples is Dubai, which plans to use blockchain in its digital passports.[23] Blockchain is a form of decentralized database that could benefit the value chain that applies to aviation in the context of aircraft manufacturers, airlines, travel agents, airports, ground handlers, and other industry suppliers who are symbiotically dependant on each other for products and services to serve their customers. IATA makes the valid observation that air transport is heading towards doing business in the digital space because the commercial aviation industry relies more on exposing their products and services and reaching a widespread distribution network that the industry is well known to, which in turn go towards more efficient management of business risks. IATA says, "[T]he inherently robust security properties (e.g., integrity, immutability) of the Blockchain technology make it very suitable as the underlying technology for digital identity management solutions."[24]

There is a danger inherent in innovative technology, where the use of innovative technology – in particular artificial intelligence – in the workplace could also have questionable consequences; for instance, the wrist band that Amazon has introduced to be worn by line workers, which tracks the hand movements of the workers and goads them to work faster, could be the modern and more humanitarian equivalent of the measures used by slave owners in forcing slaves to work faster. Firms can use AI to sift through not just employees' professional communications but their social-media profiles, too.

Artificial intelligence can result in confirmation bias when AI, which is essentially data driven, could establish patterns that enable it to discriminate against a particular group of people or race.

The Economist offers three ways to address this dilemma: anonymity, transparency, and entitlement of employees to access their data and information. The first – anonymity – is where managers do not receive individual details but instead aggregate information. This is counterintuitive, as it is difficult to evaluate how performance and competency can be assessed this way. The second – transparency – which provides information to employees as to what data is gathered, is also not helpful, as the employee may not have a choice as to the type of information that is collected. The third – access to information gathered – may only make matters worse for the employee, making them anxious and unproductive.

The purposes of AI are recognized as the ultimate promotion of the well-being of all sentient creatures. Therefore, the development of AI should promote the autonomy of all human beings and control, in a responsible way, the autonomy of computer systems. It should promote justice and seek to eliminate all types of discrimination, notably those linked to gender, age, mental / physical abilities, sexual orientation, ethnic / social origins and religious beliefs. AI's development should offer guarantees respecting personal privacy and allowing people who use it to access their personal data as well as the kinds of information that any algorithm might use. It should also promote critical thinking, protect us from propaganda and manipulation, and promote informed participation in public life, cooperation, and democratic debate. The various players in the development of AI should assume their responsibility by working against the risks arising from their technological innovations.

According to some, AI might well have the opposite effect on the well-being of sentient creatures. Bill Gates, the founder of Microsoft, opines that super intelligent systems will become "strong enough to be a concern".[25] Stephen Hawking is more vocal, stating that AI could be both miraculous and catastrophic, the "biggest event in human history but also potentially the last unless we learn how to avoid the risks."[26] Nick Bostrom, a recognized AI guru from Oxford University, warns that it could quickly turn dark and dispose of humans. Elon Musk, founder of SPACEX, calls AI "our biggest existential threat"[27] which would be tantamount to "summoning the demon". Others are more sanguine: Michio Kaku, a theoretical physicist and author, says that even if robots get out of control, we could "put a chip in their brain to shut them off".[28] Sam Altman, a renowned computer programmer, says that AI could be programmed to work towards benevolent ends only. Inventor Ray Kurzweil, Director of Engineering at Google, is of the view that the world is under a moral imperative to use AI for benevolent purposes, such as to find cures for diseases while ensuring that "we control the peril".[29]

The problem is that AI merely mimics human biology to solve problems that cannot be solved by classical mathematics. We do not even have a definition of "natural

intelligence" to distinguish it from artificial intelligence. Robots learn, and are capable even of learning by themselves, which is called singularity. We humans must learn under supervision and that is why we have to initially go to school. As humans we have feelings that are integrally associated with sensations such as remorse, guilt, recrimination, gratitude, and sadness. We practice integrity, which is doing the right thing even when no one is looking. This is our limbic system of the brain in action. We rescue others in distress even without thinking or waiting for algorithms to kick in.

MIT uses the word "extended intelligence" instead of "artificial intelligence" and IBM's Watson is considered not a replacement for human intelligence but a tool that would augment human intelligence.

One cannot conclude a discussion on innovative technology without alluding to the ominous threat of cyber terrorism. Cyber terrorism defines our times. It has brought seismic changes to the way we approach terrorism. This is because global and national reliance placed on cyberspace for the development and sustenance of human interaction will continue to grow in the years to come and with that continued development will come ominous threats and daunting challenges from cyber terrorism. Cyber terrorism has the advantage of anonymity, which in turn enables the hacker to obviate checkpoints or any physical evidence being traceable to him. It is a low-budget form of terrorism where the only costs entailed in interfering with the computer programs of a state's activities and stability would be those pertaining to the right computer equipment. The most intractable challenge posed by cyber terrorism is that the digital environment that we live in, which enables us to create and share knowledge, also provides ample opportunity for the commission of a cyber crime, since that environment breeds motivated offenders who can develop covert capabilities that could exploit the vulnerability of the cyber environment. The opportunities the cyber environment offers for subterfuge present another challenge to be overcome. However, the most ominous challenge is the lack of sentinels to guard against crimes committed against the digital world.

5. Rapid Urbanization

One of the signal effects of the globalization shift and increased global competition is migration to cities. In the past 40 years the rate of global migration has tripled, concentrating on urban areas. Half the world is living in cities and the East dominates population spread and growth. In 1950, the western world had 20 percent of the global population. Now it has only 10 percent. If China were to be divided into countries along the lines of the European Union in terms of population spread, it would have 99 countries. However, China has to be vigilant and guard against a possible collapse of

its "growth targets" in its massive growth impetus that sees what some call "phantom cities and towns" being developed. The country has to make sure its managed growth can accommodate this initiative.

Urbanization is the result of economic development and industrialization, which impel humans to migrate from rural areas to cities. Authors Peng, Chen, and Yen, in their paper "Urbanization and its Consequences" say,

> Demographically, the term urbanization denotes the redistribution of populations from rural to urban settlements over time. However, it is important to acknowledge that the criteria for defining what is urban may vary from country to country, which cautions us against a strict comparison of urbanization cross-nationally. The fundamental difference between urban and rural is that urban populations live in larger, denser, and more heterogeneous cities as opposed to small, sparser, and less differentiated rural places.[30]

At the core of urbanization lies the natural human instinct to achieve better living standards according to a hierarchy of needs. Abraham Maslow, a distinguished philosopher, opined that we all live within a hierarchy of needs. The primary need is to be able to breathe and have food, drink, and shelter. The secondary need is to be safe and secure and be free of personal danger and evil. Some of us take fulfilment of these needs for granted while others consider it futile even to dream of or aspire to having these fundamental human needs met.

Sustainable development of cities and communities is one of the Sustainable Development Goals of The United Nations. The United Nations has recorded that in 1995 there was a palpable growth and increase in urbanization across the Americas, most of Europe, parts of western Asia, and Australia. Continentally, South America was the most prolific in urbanization (except for Guyana). Peng, Chen, and Cheng summarize:

> More than 80 percent of the population lived in towns and cities in Venezuela, Uruguay, Chile and Argentina. Levels of urban development were low throughout most of Africa, South and East Asia. Less than one person in three in sub-Saharan Africa was an urban dweller. The figure was below 20 percent in Ethiopia, Malawi, Uganda, Burkina Faso, Rwanda and Burundi. An estimated 40 percent of China's 1.2 billion people and 29 percent of India's 0.96 billion lived in cities and towns. The Himalayan kingdom of Bhutan was reckoned to be the world's most rural sovereign state, with only six percent of its population living in urban places.[31]

This phenomenon of exponential urbanization – which is a trend that continues – has to be balanced with development aimed at ensuring a spread between cities. There are some states where the disparity between the major (capital) city and the second-

largest city is quite substantial. Thailand is an example, where Bangkok's population and commercial importance is ten times that of Chiang Mai, its second-largest city. India is also an example where the difference in commercial importance between big cities such as New Delhi and Mumbai and secondary cities is quite significant. This not only gives rise to rural dissatisfaction and in some cases revolt against the government establishment, but also greatly stultifies growth. In turn this would stultify connectivity with the outside world and lead to the inability to engage in disruptive innovation due to inability to attract new markets and retrogression in air transport in the country. Ruchir Sharma, in his book *The Rise and Fall of Nations*[32] says,

> To make the most of any geographical advantage, leaders also have to bring their own most backward provinces into the global provincial flow…. [T]he ten-million plus population of central Bangkok is more than ten times larger that the population of Thailand's second largest city…. A ratio that lopsided is abnormal in any country with a sizeable population…. A look at twenty of the major midsize emerging nations shows that in most, the population of the largest city outnumbers that of the second city by that of three to one … ranging from Poland, Turkey, Colombia, and Saudi Arabia to Kenya Morocco, Vietnam, and Iran.[33]

An OECD report states that by the mid-21st century the world population will reach 10 billion and will continue to grow. Africa will be the biggest contributor, responsible for more than half of this growth, which will generate significant young demographic surges that would, in the author's views, resemble the global tribe. Ageing of populations will continue and, by 2050, 10 percent of the population will be over the age of 80. This could result in the work force being depleted, resulting in a threat to existing living standards. To balance this trend, technologies that enhance physical and cognitive capacities could enable older people to work longer, and the exponential development of automation will greatly diminish the demand for human labour. 90 percent of the growth will occur in Asia and Africa. Urban living could be greatly advanced in terms of better access to electricity, water, and sanitation. There will be smart cities in developed regions which connect utility and transport networks and systems, efficiently enabling these cities to manage resources more sustainably.[34]

Although the allure of urbanization is the promise of employment, stability, prosperity, security, and social inclusion, which usually make lives safer, healthier, sustainable, and more liveable, the downside of urbanization is that in many developing countries governments are overwhelmed and unable to cope with the challenge of vast migration from rural to urban areas. Consequently, challenges exist in providing basic infrastructure, leading to substandard provision of services, threatening the health and well-being of urbanized societies.

6. Demographic Change

It is forecast that there will be an exponential growth spurt in global population over the next few years to 9.6 billion from about 7 billion today. Nine countries will be the prime contributors: India, Nigeria, Pakistan, Ethiopia, Tanzania, Uganda, Indonesia, Congo, and the United States. Due to advancements in medical technology and sciences the global ageing population (65 years and above) will significantly increase, almost doubling to 1.3 billion by 2050. More importantly, the world will witness a growing phenomenon – the growth and impact of the millennial cohort as an influencer and key driver of the global economy and as a socio-economic group.

There is a global mindset that is sweeping through the world. Often referred to as The Global Code, which is a new culture of universal values that is reshaping business and marketing, it is driven by the largest living generation – the millennials – who use innovative technology, codes, and algorithms that introduce these values of what is called *The Global Tribe* (another term for millennials) or *Satellite Tribe*, who will be responsible for two sub trends that will directly impact aviation. These are *The Gypsy Complex* – where the Global Tribe will associate with each other through international travel (with no permanent home) and *Reverse Brain Drain*, which is a massive reverse movement of highly educated and skilled workers back to their homelands in 2020. This movement in the labour force will have a huge impact on the economy and industry, particularly for aviation.

In Asia, millennials (Y generation of 25-35-year olds) comprise 58 percent of the population and occupy 25 percent of its workforce. Twenty-seven percent of China's population are millennials, and they amount to 29 percent of the population of India. Eastspring Investments forecasts that in the United States by 2020, one in every three adults will also be a millennial. The cumulative effect of this generation will be that millennials will far exceed the baby boomers in purchasing power and travel.

Millennials comprise the tech savvy young who are plugged in throughout the day to social media and the internet. Their life support is derived through connectivity. The Pew Research Centre opines that in 2036 millennials could amount to 81.1 million.[35] They are the ones who mostly use the travel apps and have income to spare and treat travel almost as a daily part of their lives. Millennials' travel patterns have been identified as follows: "85% of millennials check multiple sites before booking their travel to get the best deal possible; 46% book travel through a smartphone or tablet; 60% will upgrade their travel experience by purchasing in-flight wi-fi, early deplaning, etc. They WILL post their experiences on social media. In fact, 97% will post while traveling, and 75% will post once a day. That's a lot of social activity. 68% will remain

loyal to a program that offers them the most rewards; Cash / Freebies'; Upgrades; Discounts."[36]

Millennials are team builders and team players who believe in good governance. They follow the view that governance is the process of decision-making and the process by which decisions are implemented (or not implemented as the case may be). They categorize governance into several institutional bases and use it in several contexts such as corporate governance, international governance, national governance, and local governance. Millennials also influence global investment through their link to artificial intelligence. They will make supply and demand shift to accord with their tastes, beliefs, and economic proclivities.

Millennials will be largely living in what author Steve Case calls the "Third Wave" which will be defined by the "Internet of Everything" – in other words, where everything is interconnected.[37] This ties in with the systemic nature of demography and innovative technology. Case speaks of the three waves: we have already seen the First Wave, which was when we got connected to the internet with rudimentary computers, and the Second Wave, when there was a surge in the use of the internet and smart phones as well as the introduction of social media such as Facebook. Millennials and innovative technology have inextricable links to aviation in that airlines seeking to cash in on disruptive innovation with the millennial market will have be to be ready with apps and connecting tools that can boast of having the internet of things involved in the product they offer this new market. There is every likelihood that the third wave could disrupt every competitor unless they step up to the Third Wave. One of the key strategies in the internet of everything is forming partnerships with the "connectors". For instance, an airline which wins the new market of millennials would have to be in partnership with the providers of up-to-date in-flight entertainment systems.

It is known that the current annual carriage of 3.7 billion passengers will double in 15 years' time, and this increase will comprise a sizeable number of millennials who will be living in large hubs. This will encourage the air transport industry to look at hubs as an attractive prospect. With global unity being threatened and protectionism on the move in several parts of the world, along with the increase in demand for hyper connectivity, the air transport product should adopt a business model of adapting to cultural integration and absolute freedom of movement of airlines without restraint. To do this, states need to veer their approach from pure commercial interests to national interests. Millennials as a new market contribute much to this equation. A report by Standard & Poor's U.S. chief economist Beth Ann Bovino states that the millennials, born from 1981 to 1997, number 80 million and spend an annual $600 billion. By 2020, they could account for $1.4 trillion in spending, or 30 percent of total retail sales.[38]

From a purely commercial perspective, millennials comprise a new market for the entire aviation industry, giving the opportunity for disruptive innovation, which is a business concept that resonates with millennials – a business concept straight out of the Harvard Business School that could well be applicable to political strategy. Disruptive innovation is innovation which helps create a new market and value network that disrupts the existing market. The theory of disruptive innovation was first coined by Harvard professor Clayton M. Christensen in his research on the disk-drive industry and later popularized by his book *The Innovator's Dilemma*, published in 1997. Examples of disruptive innovation abound in the commercial world. For instance, Wikipedia disrupted the market established for more than 200 years by *Encyclopedia Britannica*. The iPhone disrupted the market of the desktop and laptop computers in many areas.

A good example of millennials and their link to disruptive innovation can be seen in the decision of Boeing to manufacture its Dreamliner 787, which caters to a new market of point–to-point traveler, which is typical of the millennials' travel preference. The aircraft is smaller than its rival Airbus A380 but is capable of operating over long distances, reducing the need for connections and layover times at airports. From the millennials' perspective of eliminating time lags in airports, the Boeing 787 surpasses the Airbus 380, and aircraft manufacturers are already planning aircraft with vertical takeoffs that would bring the landing of an aircraft closer to cities – another factor favouring the millennials' choices.

7. Environmental Protection/Climate Change

Environmental protection did not become a serious concern to the international community until a few decades ago**.** There were no texts on the subject and academic journals were bereft of any material on law and the environment, particularly prior to 1972 when the Stockholm Conference[39] on the Environment took place. One commentator attributes this trend to apathy or the focus of interest by the international community on other pressing issues.[40] However, there has been much awareness, progress and evolution in the field of environmental law and regulation since 1972. To begin with, the declaration adopted at the Stockholm Conference alerted the world to the importance of environmental protection, stating that man is both creature and moulder of his environment, which gives him physical sustenance and affords him the opportunity for intellectual, moral, social, and spiritual growth. The declaration went on to say that in the long and tortuous evolution of humans on this planet a stage has been reached when, through the rapid acceleration of science and technology, man has acquired the power to transform his environment in countless ways and on an

unprecedented scale. Both aspects of human beings' environment, the natural and the human-made, are essential to our well-being, to the enjoyment of basic human rights, and to the right to life itself.

Arguably the most important pronouncement of the Stockholm Declaration lies the recognition enunciated in Principle 21, that states have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own natural resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states or of areas beyond the limits of national jurisdiction.

Principle 21 therefore became the fundamental postulate of environmental law on which subsequent developments responding to environmental issues would hinge. It is important to note that although the principle states that countries can exploit their natural resources and it is their sovereign right to do so, they should do so without harming the environment of other countries and the global environment. It is this caveat that has led to Principle 21 being known as the principle of harm prevention.

The Stockholm Declaration of 1972 also brought to bear the fact that the protection and improvement of the human environment is a major issue which affects the well-being of peoples and economic development throughout the world, and therefore such protection and improvement is the urgent desire of the peoples of the whole world and the duty of all governments. It also highlighted the fundamental cause of environmental pollution by focussing on the fact that, in the developing countries in particular, most environmental problems are caused by under-development. Furthermore, the declaration recognized that millions continue to live far below the minimum levels required for a decent human existence, deprived of adequate food and clothing, shelter and education, health and sanitation. Therefore, the developing countries must direct their efforts to development, bearing in mind their priorities and the need to safeguard and improve the environment. The declaration went on to assert that, for the same purpose, the industrialized countries should make efforts to reduce the gap between themselves and the developing countries. The basic issue was that in the industrialized countries environmental problems are generally related to industrialization and technological development.

Arguably, the three most important principles of the Stockholm Declaration were as follows: firstly, that the natural resources of the earth, including the air, water, land, flora and fauna, and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate; secondly, that the capacity of the earth to produce vital

renewable resources must be maintained and, wherever practicable, restored or improved; and thirdly, (explicit in Principle 6) that the discharge of toxic substances or of other substances and the release of heat, in such quantities or concentrations as to exceed the capacity of the environment to render them harmless, must be halted to ensure that serious or irreversible damage is not inflicted upon ecosystems. The just struggle of the peoples of all countries against pollution should be supported. Principle 12 went on to say that resources should be made available to preserve and improve the environment, considering the circumstances and requirements of developing countries and any costs which may emanate from their incorporating environmental safeguards into their development planning and the need for making available to them, upon their request, additional international technical and financial assistance for this purpose.

These principles formed both the genesis of and precursor to action on environmental protection. The Rio Conference on Environment and Development,41 which took place in 1992, was another landmark in global legislative and regulatory initiative. This conference adopted the Rio Declaration, which, while endorsing the Stockholm Declaration and its principles, stated that, in order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it. The declaration, in Principle 7, called for states to cooperate in a spirit of global partnership to conserve, protect, and restore the health and integrity of Earth's ecosystem. In view of the different contributions to global environmental degradation, states have common but differentiated responsibilities. By adopting the Rio Declaration, the developed countries acknowledged the responsibility they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command. The declaration also called for global and consensual efforts at environmental protection, stating inter alia in Principle 12 that unilateral actions to deal with environmental challenges outside the jurisdiction of the importing country should be avoided. Environmental measures addressing transboundary or global environmental problems should, as far as possible, be based on an international consensus. From an aviation context, as will be seen in later discussions on aircraft engine emissions, the principle of consensus enunciated in Principle 12 has become a contentious issue, particularly related to emissions trading.

At the Earth Summit in Rio, the international community adopted Agenda 21, an unprecedented global plan of action for sustainable development. Agenda 21, which was adopted by more than 178 governments at the summit, is a comprehensive plan of actions to be taken globally, nationally, and locally by organizations of the United Nations system, governments, and major groups in every area in which humans impact

the environment. Part of Agenda 21 was to establish the United Nations Commission on Sustainable Development (CSD),[42] which was created in December 1992 to ensure effective follow-up of the Rio Conference to monitor and report on implementation of the agreements at the local, national, regional, and international levels.

The World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa from 26 August to 4 September 2002 strongly reaffirmed and endorsed the full implementation of Agenda 21, the Programme for Further Implementation of Agenda 21, and the commitments to the Rio principles. It was in essence a clarion call to the world to endorse and adhere to the earlier declarations. It could be said that one of the signal contributions of the Johannesburg Summit was that it acted as the precursor to a link between human rights law and environmental law. Sumudu Atapattu,[43] a renowned environmental law scholar and professor at the University of Wisconsin, is of the view that this link is most commonly seen in South Asia. She cites the right to health and the right to adequate standards of living as economic and social rights that touch on environmental issues.

Access to information is also a right enshrined in the general principles of environmental law. Principle 10 of the Rio Declaration states *inter alia* that at the national level everyone is entitled to have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. This abundantly shows that good governance is an integral element and critical requirement in the environmental decision-making processes of a country and facilitates achieving sustainable development.

Rising global population, an exponential increase in global consumption, materialism, a fast pace of life, and changing lifestyles have all contributed to pollution.

Climate change is arguably the most disturbing megatrend facing the Anthropocene. The concern of the world is that there will be serious adverse effects on the world if the global temperature rises by more than 1.5 degrees Celsius above pre-industrial levels. On 4 November 2016 the Paris Agreement entered into force, by which time at least 55 countries, accounting for 55 percent of the total global greenhouse gas emissions, had deposited their instruments of ratification, acceptance, or approval with the United Nations. The 1.5 degree target was easily reached since the biggest polluters, the United States, China, countries of the European Union, and India together account for 42 percent of the greenhouse gases emitted on the planet. To date 77 countries have ratified the agreement, leaving more than 100 countries yet to ratify it.

ICAO Resolution A 39-3, adopted at the 39th session of its assembly in 2016, acknowledges the adoption of the Paris Agreement and recognizes that the work related

to a global market-based measures (GMBM) scheme for international aviation and its implementation will contribute to the achievement of the goals set out in the agreement. It introduces a GMBM scheme that would be implemented in the form of a Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to address any annual increase in total CO2 emissions from international civil aviation (i.e., civil aviation flights that depart in one country and arrive in a different country) above 2020 levels, considering special circumstances and respective capabilities (SCRCs) of states. CORSIA would be implemented in three phases while accommodating SCRCs, particularly of developing states, and at the same time minimizing market distortion. The resolution was in response to a specification in Resolution A38-18, adopted at the assembly three years earlier, which required the assembly to develop a GMBM scheme in 2016. It took six years, from the 37th assembly in 2010 (which required the council to explore the feasibility and modalities of a GMBM scheme) to the 39th session in 2016, for ICAO to come up with a scheme, which, until 2024 will be a voluntary pilot scheme that will not be an active GMBM. Thereafter, through 2027 the scheme will still be semi-experimental. In the meantime, pollution caused by engine emissions will exponentially grow over the next ten years.

CORSIA – which applies only to international civil aviation – is to be implemented through an annex – Annex 16 Volume IV, Part II – to the Chicago Convention.[44] The annex prescribes a monitoring, review, and verification (MRV) model, the applicable scope of which is stipulated in Chapter 2, to the effect that the Standards and Recommended Practices (SARPs) of the annex are applicable to an aircraft operator that produces annual CO_2 emissions greater than 10,000 tonnes from the use of an aircraft or aircrafts with a maximum certificated take-off mass[45] greater than 5,700 kg conducting international flights, on or after 1 January 2019, with the exception of humanitarian, medical, and firefighting flights. The chapter also recognizes specific aircraft categories which do not fall within the applicability scope and specific requirements associated with new entrants.[46]

The annex prescribes the following chronology of implementation: between 2021 and 2026 – the participation of international flights between states that decide to voluntarily participate in the scheme; between 2027 and 2035 – international flights between states that have an individual share of international aviation activities in revenue tonne kilometres (RTKs) in year 2018 above 0.5 percent of total RTKs, or whose cumulative share in the list of states from the highest to the lowest amount of RTKs reaches 90 percent of total RTKs. International flights between state pairs which include least developed countries (LDCs), small island developing states (SIDS), and

landlocked developing countries (LLDCs) are not within the applicability scope of the offsetting requirements, unless the state decides to voluntarily participate.[47]

The above notwithstanding, the hope lies mainly in research and development toward mass production of alternative fuels. There are currently no sustainable alternative fuels for aircraft in commercial production. However, this is expected to change soon. Planning is underway for producing new fuels with low life-cycle emissions. When these fuels enter the market, their costs will be high and they may require subsidies or production incentives in order to make them economically viable. As industry gains more experience producing these fuels their costs will decrease, as will their life-cycle greenhouse gas (GHG) emissions. In the long term, industry may design new aircraft and engines to take advantage of unconventional aircraft fuels with extremely low life-cycle CO_2 emissions.

New sustainable alternative fuels for aircraft may be better suited for regional and local production in countries around the world in light of the variety of potential feedstocks. Once refined into fuel, the feedstock used is irrelevant to the aircraft. Most of the feedstocks studied to date also produce by-products that may be of value locally. Communities may be able to develop new businesses or other sources of income from alternative fuel production. To meet these objectives, significant investment will be needed in regions where states desire to become producers of sustainable alternative fuels for aircraft.

In the short term, sustainable alternative fuels for aircraft may be available in limited quantities and have life-cycle CO_2 footprints equal to, or less than, conventional jet fuel. It will be necessary to blend these alternative fuels with conventional jet fuel up to a maximum of 50 percent to produce a drop-in fuel. Drop-in jet fuels are completely interchangeable with conventional jet fuel, and so will not require modification of fuel handling and distribution systems, including gauges, meters, fuelling vehicles, and hydrant systems, as well as aircraft engines, once the fuels have been blended.

GHG emission reductions in the short term will be limited as sustainable alternative fuels for aircraft are initially introduced. For example, assuming the life-cycle CO_2 footprint of sustainable alternative fuels for aircraft provides a 20 percent reduction compared with conventional jet fuel, and a 50 percent fuel blend makes up 10 percent of the total jet fuel market, the GHG emissions reduction would be 1 percent compared to forecast emissions without the new fuels. However, reductions in particulate matter and sulphur oxides will be more significant. Achieving air quality benefits from the use of these fuels is independent of production life-cycle considerations.

In the medium term, it is possible that sustainable alternative fuels for aircraft will be available in much larger quantities. The significant research and development activity currently underway is expected to lead to a number of commercial-scale production facilities. The Commercial Aviation Alternative Fuels Initiative (CAAFI) in 2009 was seeking to ensure that at least ten alternative jet fuel production facilities would be built and in operation within five years. Also, it was envisioned that these new fuels will have to be certified for greater use in blends, possibly up to 100 percent alternative fuel, thus moving from drop-in blend fuels to drop-in neat fuels, according to industry roadmaps. It was also envisioned that these fuels may reach cost parity, especially if the value of their carbon reduction benefits is accounted for.

As the aviation industry increases its use of sustainable alternative fuels for aircraft, ongoing efforts will have to be applied to reduce the life-cycle impacts of these fuels. These efforts may include: thoroughly exploring and identifying feedstock resources; enhancing resource quality; improving oil recovery and extraction; finding markets for co-products; creating higher-value co-products; improving the efficiency of converting raw biofuels to jet fuel; and reducing the length and number of transport links.

As for long-term availability of these fuels, the aviation industry may explore more radical fuels that require redesigned engines and airframes. Fuels such as liquid hydrogen and liquid methane might be used to significantly reduce GHG emissions. Managing these cryogenic liquids on an aircraft will require heat exchangers to vaporize and heat the fuel prior to use on-board, and the fuel supply infrastructure will need to be substantially redesigned or replaced. While new aircraft designs and new fuel production pathways may be required, these new approaches may result in more energy efficient and environmentally benign air travel.

Sustainable alternative fuels for aircraft can be produced from a wide variety of feedstocks. Oil-producing plants such as camelina, moringa, babacu, macauba, jatropha, halophytes, and algae are already being evaluated for fuel production. These plants and others can be grown in countries around the world. It is quite likely that different feedstocks can be optimally grown in different countries, suggesting that many regions are candidate production locations. Since these feedstocks have a relatively low energy density, especially compared to crude oil, it is uneconomic to ship them over long distances. As a result, sustainable alternative fuels for aircraft may be better suited to production on a local scale.

The by-products or secondary products from sustainable alternative fuels for aircraft production can become valuable inputs to local economies. These materials, such as animal feed or solid residues that can be used as fuel for cookstoves, may be valued locally even if the bio-oils are shipped out of the region for refining.

Communities may be able to develop new businesses or other sources of income from alternative fuel production. While sustainable alternative fuels for aircraft can be produced from a wide variety of feedstocks and processes, only those that attract sufficient investment will achieve a market presence. Identifying resources, producing test quantities of oil, certifying the fuels, conducting performance studies, and investing in plot plant production are all expensive. Significant investment will be required in any region where states desire to become producers of sustainable alternative fuels for aircraft.

It would be interesting to see how the $100 billion aid per annum together with the new carbon-offsetting market-based measure prescribed at the recent Assembly of International Civil Aviation Organization would contribute toward maximizing the use of alternative fuels.

8. Global Connectivity

There are two dimensions to this megatrend: one is the aviation perspective; the other is connectivity through innovative technology. In many ways these two dimensions are intertwined. In 1996, pursuant to an initiative by ICAO which was robustly assisted by the Canadian Government, the United Nations General Assembly, by resolution, officially recognized 7 December as International Civil Aviation Day and listed it as an official UN day. The purpose of the global celebration is to generate and reinforce worldwide awareness of the importance of international civil aviation in the social and economic development of states, and of the role of ICAO in promoting the safety, efficiency, and regularity of international air transport. Each year on this day, ICAO celebrates this global occasion with a theme. In 2012 the ICAO theme was "Aviation – Your Reliable Connection to the World".

"Connectivity", which is the most compelling need in aviation and embodied in the Chicago Convention as *inter alia* "meeting the needs of the people of the world for efficient and economical air transport", is stultified by commercial interests and national policies. The trouble with air transport is that, while on the one hand it is a product, on the other hand regulations pertaining to this product may constrain its availability to consumers by depriving them of the various choices of air travel they might have under a liberalized system. In other words, state policy and the protection of national interests take precedence over the interests of the user of air transport. The aviation industry offers only one product to the ultimate consumer and that is the air transport product.

This obstacle has been circumvented by various commercial alliances and partnerships between air carriers. To cite just one example, when Emirates commenced its operations to Australia in 1997, the airline was viewed with trepidation and concern

by QANTAS, as a threat to its market share. This concern was shared by the Australian authorities. However, attitudes quickly changed, and this concern was obviated when they realized the added economic benefit quickly enjoyed by the places Emirates flew to. Currently, Emirates operates 49 flights a week to Australian cities and hopes to expand this number to 80. QANTAS and Emirates are now partners.

One way in which air carriers ensure connectivity is through bilateral, regional, and multilateral open skies agreements. An open skies agreement is a bilateral or multilateral reciprocal agreement between states which allows untrammelled and unrestricted air transport to and from the parties to such a contract. It could even be a one-sided permission, where a state would open its skies to any national carrier without necessarily seeking reciprocity.

Open skies agreements are entered into by states with a view to circumventing an obstacle to air transport services contained in Article 6 of the Chicago Convention, which provides that no scheduled international air service may be operated over or into the territory of a contracting state, except with the special permission or other authorization of that state, and in accordance with the terms of such permission or authorization. Opening skies, with a view to obviating governmental interference restricting air transport operations, is a common practice in the commercial air transport world today (the United States has signed more than a hundred open skies agreements), and it mostly serves as a progressive measure towards ensuring liberalization of air transport.

As for the other dimension of connecting the world, innovative technology, there are various contributors: technology, migration, globalization, and deregulation. Computers may well be more intelligent than humans by 2030, bringing unforeseen challenges. Already billions of us are on Facebook. GRIN technologies (genetics, robotics, internet and nanotechnologies) are already with us. There is uncontrollable sharing of information, which compromises our privacy and makes us vulnerable to cyber attacks.

A corollary to connectivity is globalization and the removal of boundaries and barriers that once separated societies from each other and isolated nations. Globalization brings with it the blatant reality that increasing global connectivity, together with integration and interdependence in the economic, social, technological, cultural, political, and ecological spheres, have removed all trade barriers, making a world without boundaries. *Encyclopedia Britannica* defines globalization as the "process by which the experience of everyday life is becoming standardized around the world." Globalization reflects the inevitable corollary of the contemporaneous advancement of technology and growing trends toward liberalism in international trade. The information

and telecommunications revolution, which really kick-started in the 1980s, dramatically lowered the costs of doing business across national borders.

The giant strides made by information technology, which took its incipient steps in the 1990s, together with paradigm shifts in trade practices such as outsourcing and off-shoring, have ensured the opening of a world which no longer sees boundaries that inhibit global trade and information exchange. The movement toward outsourcing and subcontracting of services is evident in both developed and developing countries. Provision of information technology is now frequently outsourced to specialized companies. One of the distinctive characteristics of outsourcing in the context of trade is that it is not inhibited by national requirements imposing ownership restrictions, which allows trading services to blend in to the process of globalization. Off-shoring on the other hand allows a business to move its base to a country where human resources are accessible at rates lower than its home base but at the same time are of the same or higher quality than found at home. China is a good example of an attractive off-shore base.

The strongest thrust of globalization in the business world is its ability to generate competition within and between nations to offer the best goods and services at the lowest prices. The quality of services and pricing in China as an off-shore base have encouraged other nations, such as Malaysia, Thailand, Ireland, Vietnam, Brazil, and Mexico to vigorously compete as viable off-shore bases.

There is no doubt that two of the greatest catalysts in the globalization equation have been e-information and e-trade, which were individually and collectively spawned by the internet. Downloading and uploading are tools that make the exchange of knowledge instantly accessible throughout the globe. These tools, when viewed in relation to the greatest global inhibitors of all – poverty, war and ill health – open a whole new dimension of hope. There are two basic premises which are incontrovertible. The first is that globalization enhances the wealth of nations through connectivity, promotes trade, and increases the gross domestic product of a country. The second is that at the very core, a compelling need of every human being is to be part of a collective and connected to others.

9. Conclusion

At the very least, some awareness must be generated in the ICAO Council that there is an existential link between the megatrends, which will affect aviation for the next 20 years at least, and the strategic objectives of the council as well as the vision of ICAO. Mindful of the Preamble to the Chicago Convention, which states that the future development of international civil aviation can greatly help to create and preserve

friendship and understanding among the nations and peoples of the world, as well as Article 44, which gives the aims and objectives of ICAO to be "to develop the principles and techniques of international air navigation and to foster the planning and development of international air transport so as to ... [*inter alia*] meet the needs of the peoples of the world for safe, regular, efficient and economical air transport....", the ICAO Assembly, at its 50th anniversary meeting in 1994, adopted Resolution A29-1: *ICAO's 50th Anniversary Celebrations* (1994) and recognized *inter alia* that ICAO continues to work with states and through their regional and international organizations to ensure that the growth of international civil aviation continues to contribute to international peace and development. The resolution also authorized the council to work with the United Nations and its agencies to launch activities to highlight the role of civil aviation in their work.

Twenty-five years have gone by since that resolution was adopted, and in September/October 2019 ICAO faces its 40th assembly – celebrating 75 years of ICAO. Part of ICAO's 75th anniversary celebrations should be to institute a study as to where international civil aviation is headed in the face of megatrends that affect the world. It must be noted that Article 55 c) of the Chicago Convention leaves room for the council of ICAO to conduct research into all aspects of air transport and air navigation which are of international importance, communicate the results of its research to the contracting states, and facilitate the exchange of information between contracting states on air transport and air navigation matters. This is followed by Article 55 d, which gives the council discretion to study any matters affecting the organization and operation of international air transport, including the international ownership and operation of international air services on trunk routes, and submit to the assembly plans in relation thereto.

It cannot be said that ICAO has done nothing in this regard. ICAO has convened meetings of its member states to discuss, in global fora, the future of air navigation in a changing world[48] as well as in its assemblies, which focus on safety, security, and the environment. However, it is time to present a detailed study of how megatrends would affect air transport of the future. Such a study could address the interplay between megatrends: the effect that the exponential increase in urbanization could have on congestion and environmental change, and the interplay of these with the increasing trend towards connecting people across the world; the needs of the Y and Z[49] generations and the economic power shift to the East; and the overall effect of information technology on all other megatrends. At the least, there should be a preliminary study that could spur the 40th session of the assembly into action towards

requesting the ICAO Council to establish a study group of state experts who would then address the composite issues in the greatest detail possible.

Endnotes

[1] DCL (McGill), PhD (Colombo), LL.M (Monash), LL. B (Colombo) FRAeS. The author is former Senior Legal Officer at the International Civil Aviation Organization.
[2] Global economy in 2019: Growth beginning to fray, *The News International*, Monday 18 February 2019. See https://www.thenews.com.pk/latest/404996-global-economy-in-2019-growth-beginning-to-fray
[3] Article 50 provides *inter alia* that any member state may decide to withdraw from the Union in accordance with its own constitutional requirements; a member state which decides to withdraw shall notify the European Council of its intention. In the light of the guidelines provided by the European Council, the Union is required to negotiate and conclude an agreement with that state, setting out the arrangements for its withdrawal, taking account of the framework for its future relationship with the Union. That agreement must be negotiated in accordance with Article 218(3) of the Treaty on the Functioning of the European Union. It will be concluded on behalf of the Union by the Council, acting by a qualified majority, after obtaining the consent of the European Parliament.
[4] The Treaty of Lisbon was signed by the EU members on 13 December 2007 and entered into force in December 2009.
[5] The EU-US Air Transport Agreement signed on 25 and 30 April 2007, the main purpose of which is to establish a Trans-Atlantic open aviation area, was provisionally applied from 30 March 2008 for all EU member states, and amended by a Protocol, signed and provisionally applied on 24 June 2010. Norway and Iceland's accession to the Air Transport Agreement as amended by the Protocol is provisionally applied from 21 June 2011.
[6] EUROCONTROL, which is the European Organisation for Safety of Air Navigation and is made up of 39 member states of the European Community, forecasts that there will be 16.9 million aircraft movements in Europe in 2030, which is approximately 2 percent more than the movements in 2009. The number of flights concerned is estimated between 13.1 to 20.9 million flights during 2030.
[7] A study of the effects of the United Kingdom leaving the European Union on airlines flying to and from the UK, R-038-001-001 Final, at https://www.iata.org/policy/consumer-pax-rights/Documents/iata-brexit-study.pdf
[8] *Id.* 28.
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[13] Boeing World Air Cargo Forecast 2016-2017. http://www.boeing.com/commercial/market/cargo-forecast/
[14] Aviation Benefits: Contributing to Global Economic Prosperity, Uniting Aviation: Bringing Air Transport Partners Together, http://www.unitingaviation.com/strategic-objective/economic-development/aviation-benefits-for-a-better-future/
[15] Outlook to 2042, ICAO World Civil Aviation Report: 2016, supra, note 10 at 44. In 2015, 3.5 billion passengers were carried by air worldwide.

[16] John Leahy, Chief Operating Officer, Airbus Industrie, *Airbus Market Forecast 2010-2029*, https://www.scribd.com/document/66638952/Airbus-Global-Market-Forecast-2010-2029
[17] International Tourist Arrivals Reach 1.4 billion Two Years Ahead of Forecasts: UNWTO: Geneva, 21 January 2019. See http://www2.unwto.org/press-release/2019-01-21/international-tourist-arrivals-reach-14-billion-two-years-ahead-forecasts. See also generally Tourism Towards 2030: Global Overview, UNWTO: Madrid, at https://www.globalwellnesssummit.com/wp-content/uploads/Industry-Research/Global/2011_UNWTO_Tourism_Towards_2030.pdf
[18] Artificial Intelligence in aviation. What is it and when is it coming? *ICAO Now*, 17 August 2006, at https://www.icaonow.com.br/single-post/2017/04/16/Artificial-Intelligence-in-Aviation-What-is-it-and-when-is-it-coming-English-Practice
[19] *Ibid*. Identified as at risk are physical jobs that are repetitive in nature and data collecting and processing jobs. Less at risk further down the line are physical, unpredictable jobs and jobs that require application of expertise. Jobs that are most difficult to replace are jobs that involve emotional interaction with people. A separate study has concluded that the computer/digital revolution favours more-skilled over less-skilled workers and it reduces employment and constrains wage growth. See Laura Tyson and Michal Spence, Exploring the Effects of Technology on Income and Wealth Inequality, *After Piketty: The Agenda for Economics and Inequality* (Boushey, Delong and Steinbaum ed.,) Harvard University Press: 2017, 170-208, at 171.
[20] SITA is a multinational information technology company providing information technology and telecommunication services to the air transport industry. The company provides its services to over 430 members and 2,800 customers worldwide, which is around 90 percent of the world's airline business. It is the world's leading specialist in air transport communications and information technology.
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[23] CoinDesk, at https://www.coindesk.com/dubai-plans-gate-less-airport-security-using-blockchain-tech
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[31]Xizhe Peng, Xiangming Chen, and Yuan Cheng, Urbanization and its Consequences - DEMOGRAPHY – Vol. II, 7.

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[33] *Ibid*.
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[40] Sumudu A. Atapattu, *Emerging Principles of International Environmental Law*, Series on International Law and Development, Transnational Publishers, Ardsley: 2006 at 1.
[41]United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, 3 to 14 June 1992. See UN Doc.A/CONF.151/26, reprinted in 31 *ILM* 874(1992). It must be mentioned that in the 1980s the UN set up the World Commission on Environment and Development, also called the Brundtland Commission. They produced *Our Common Futur*e, otherwise known as the Brundtland Report, which framed much of what would become the 40 chapters of Agenda 21 and the 27 principles of the Rio Declaration on Environment and Development. It defined sustainable development as development which "meets the needs of present generations without compromising the ability of future generations to meet their own needs".
[42] The United Nations Commission on Sustainable Development (CSD) was established by the UN General Assembly in December 1992 to ensure effective follow-up of the United Nations Conference on Environment and Development, or UNCED, also known as the Earth Summit. The commission is responsible for reviewing progress in the implementation of Agenda 21 and the Rio Declaration, as well as providing policy guidance to follow up the Johannesburg Plan of Implementation (JPOI) at the local, national, regional, and international levels. The JPOI reaffirmed that the CSD is the high-level forum for sustainable development within the United Nations system.
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[46] Annex 16 Part IV, Chapter 2.1.1.
[47] Annex 16 Part IV *Id.*, at 3.3.1.
[48] For example, the second Global Air Navigation Industry Symposium (GANIS/2) in 2017, which addressed air navigation systems and how they could cope with future increases in air transport and congestion both in the skies and on the ground at airports.
[49] There is no precise date for when Generation Z begins, but demographers and researchers typically use the mid-1990s to mid-2000s as starting birth years. There is little consensus regarding ending birth years.