

The Coming Aerospace Squeeze

A review of Commercial Aerospace Programs in Brazil, Canada, China, Japan & Russia



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Executive Summary

The commercial aerospace programs under development in Brazil, Canada, China, Japan and Russia (BCCJR) will soon challenge the dominance of Boeing and Airbus for commercial aircraft between 100 and 210 seats. Because this sector is forecast to include 16,977 new aircraft valued at over \$850 billion¹ over the next 20 years, a shift in production from the US and EU to new competitors will have a significant impact on the United States, France, Germany, Spain and the UK.

Any business opportunity of such magnitude is always attractive in terms of employment, jobs, and is a target for politicians. Consequently, government support of aerospace is commonplace, as demonstrated by the WTO cases against Airbus and Boeing. As politicians in Brazil, Canada, Japan, Russia and China examined the market for commercial aircraft, they have all sought to extend their national participation through financial support. And while the WTO may strip Airbus and Boeing of certain funding mechanisms, they will find other ways to take their place.

The regional aircraft market, once dominated by the EU and US with Beechcraft, Fokker, BAe, Saab, ATR and others as the main suppliers has dramatically changed. Bombardier in Canada and Embraer in Brazil are now the dominant players. Could a similar transition occur for aircraft in the 100- to 200-seat category? We believe that answer is yes, and that new competitors will begin to seriously challenge Boeing and Airbus in the 2015-2020 timeframe unless the two current industry leaders leapfrog their emerging competitors through technological innovation.

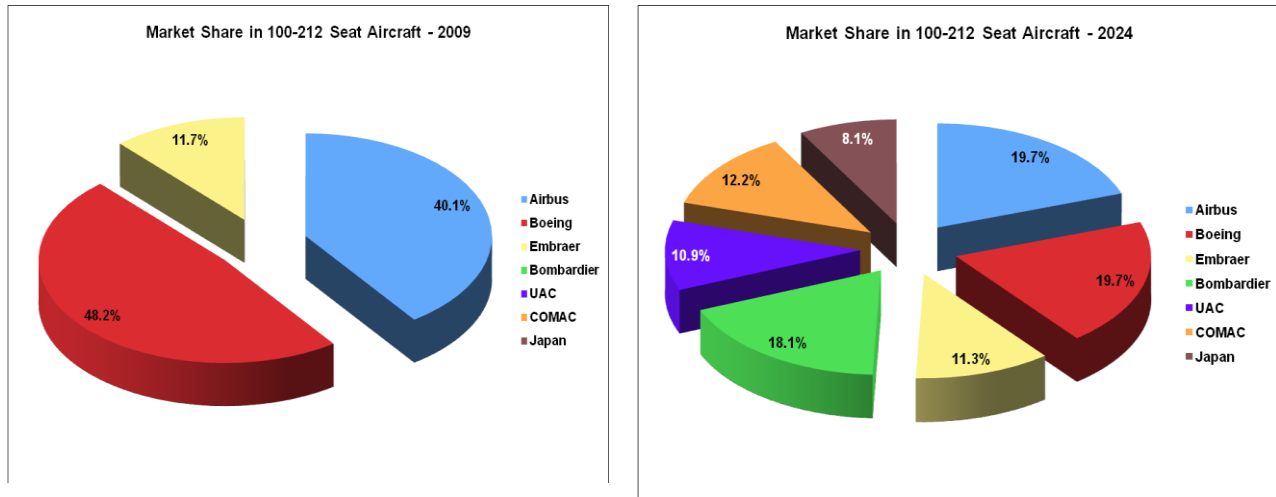
The demise of the 70- to 100-seat regional jet market will impact that transition. The economic viability of regional jets, particularly in the low-yield US market, has changed dramatically. The 50-seat regional jet market is moribund, with virtually no orders in the last few years. Similarly, the economics of 70-90 seat regional jets are also changing. We believe the under 100-seat regional jet market, with high fuel prices and low yields, is rapidly ending, reaching the inflection point of economic viability, if it hasn't already. As a result, regional jets will begin to grow into the 100- to 130-seat segment.

The balance-of-trade and employment economic impacts of such changes are significant. Consider the forecasts of demand for 100-210 seat airliners developed by Airbus and Boeing, who share that market today as a virtual duopoly, with 88% market share. Bombardier in Canada, UAC in Russia and COMAC in China, project program volumes may siphon one-third of that demand. Add in Embraer and the Japanese, and either the pie must grow, or Airbus and Boeing face a potential 40% reduction in their cash cow share of the narrow-body market. Boeing and Airbus produce about 65 single-aisle aircraft per month. By 2028, this number could fall to 35, with hundreds of billions of dollars in revenue moving from the Big 2 to the Emerging 5.

While we don't believe each of the new competing programs will be as successful as they individually forecast, it is clear that the market share for Airbus and Boeing will fall significantly during the next 20 years for the 100-210 seat aircraft. At a minimum, the impact of domestic markets, combined with

¹ Airbus 2009 Global Market Forecast, published September 2009.

additions to industry capacity will induce future price competitiveness for undifferentiated products. The key for Boeing and Airbus will be keeping ahead of the competition, which is more difficult when technologies are shared and major subcontractors are willing to participate with emerging programs.



As Western aerospace companies have transferred production of key aircraft components to foreign firms, these subcontractors have also gained intellectual property and skills that have helped them become full-fledged competitors. Furthermore, key systems are readily available from industry suppliers, to the point that in Russia the Sukhoi Superjet was rejected as a government transport because it lacked adequate Russian content in favor of the “more-Russian” competitor from Antonov. The critical skill necessary for success is the ability to integrate these elements and manage a program. Bombardier and Embraer have proven that skill with their Regional Jets, and the Russian aircraft industry has longstanding experience. Japan and China, whose aircraft have been relatively unsuccessful commercially, also have that capability and the resources to invest in order to obtain skills they may require.

Airbus and Boeing, and more recently Bombardier and Embraer, by outsourcing with and contracting to these emerging competitors in the name of “strategic partnerships”, have been laying the very foundation for these new competitors. Airbus and Boeing will soon suffer the consequences as a duopoly rapidly becomes a highly competitive sector. The long-term competitiveness of the US and EU in aircraft manufacturing will be negatively impacted over the next decade, and the economic ramifications will be significant. A number of factors influence our conclusions:






- ***The regional jet segment, currently dominated by Bombardier and Embraer, will soon include new technology competitors from China, Russia and Japan, as well as new models from Bombardier.*** With poor sales from the smallest models from Airbus and Boeing (A318 and 737-600 respectively), this sector will continue to be dominated outside of the US and EU, and today’s Brazilian-Canadian duopoly may be invaded by three new competitors.

- ***The technology behind regional jets is not materially different than the technology for a 150-seat narrow-body jet.*** The major difference is scale. While full composite structures such as the 787 have not yet been employed, advanced aluminum-lithium alloys and the latest proven aerodynamics and wings are using the same strong base of international suppliers who also supply Boeing and Airbus. With the 737NG introduced in 1994 and the A320 in 1988, the existing narrow-body programs are not technologically innovative, and thereby ripe for competitive attack with more modern technology.
- ***New engine technology is available for regional jets.*** Today, rather than a debut with an Airbus or Boeing airframe, Pratt & Whitney will introduce its new PurePower geared turbofan in two regional aircraft, the Mitsubishi Regional Jet and the Bombardier CSeries. While Pratt & Whitney are also offering this new technology to Airbus and Boeing, they will not be the launch customers for this innovative new engine technology. Similarly, the Powerjet Sam146, produced by a joint venture of Snecma in France (who are partners with GE in CFM) and NPO Saturn in Russia is utilizing technology similar to the next generation LEAP-X engine from CFM.
- ***It is only a short leap from a regional jet to a trunkliner, and Bombardier has made that jump with its CSeries.*** Embraer may be forced to follow or find their E-Jets economically obsolete through new engine technology in less than ten years since their introduction. China will produce the C919, Russia the MS-21, and in Japan the Kawasaki YPX is emerging from the drawing board to provide new competition to Airbus and Boeing in the narrow-body segment.
- ***Boeing and Airbus, through international partnerships, have been transferring technology to partners that may have enabled them to become potential competitors.*** Airbus and Boeing have developed international supply chains and have significant elements of their aircraft manufactured in China, Japan (also a risk-sharing partner to Boeing on 787), and other countries. Airbus and Boeing have outsourced engineering services in Russia, providing direct access to elements of its designs. We believe they have been feeding the hand that will come back to bite them through their globalization efforts.
- ***Neither Boeing nor Airbus can afford to develop a new technology narrow-body aircraft in the timeframe customers are seeking – circa 2015.*** Airlines have asked Boeing and Airbus to move forward with new models even if fuel efficiency is only 15% better than today's models. With major cost overruns on the A380, A400M, 787 and 747-8 programs, neither manufacturer has a development budget available for a new program on top of the existing A350 and likely 777RS,. This provides a window of opportunity for competitors using new engine technology to offer alternative programs. Boeing has postponed its 737 replacement aircraft until at least 2020, and Airbus its A320 replacement until 2024.
- ***As a result, it is highly likely that Airbus and Boeing will re-engine existing aircraft with new technology engines.*** But since these are the same engines that will be utilized by new aircraft built by the five emerging aerospace powers, these new airframes will likely offer better





economics. These models should sell well in their domestic markets, with China and Russia in significant need of both additional and replacement aircraft. These new aircraft will also likely be less expensive than their Boeing or Airbus competitors.





- ***Bombardier and Embraer have established service and support organizations that can challenge Airbus and Boeing.*** Support is a critical function for airlines, and risk-averse airlines will avoid aircraft if support, parts, and service are not readily available. This places new competitors from Japan, Russia and China at a disadvantage in world markets, but these disadvantages could be overcome through alliances with major MRO organizations such as Lufthansa Technik. Embraer has shown the way for a developing country to succeed in developing a world-class aviation sector, and Japan, Russia and China have closely examined the key elements in its success.
- ***Airbus and Boeing are working on advanced technology replacements for the 2020-2024 timeframe.*** Just as the A380 and 787 were ground-breaking, Boeing and Airbus need to once again break ground with innovative new designs if they are to maintain leadership over their emerging competitors. The potential for innovative designs – from unducted fans mounted on pi-tails to flying body concepts--could provide the technological breakthroughs necessary to deflect a shift in market share. For Boeing and Airbus, the introduction of radical new technology is an imperative, rather than simply an alternative to consider.
- ***If Boeing and Airbus introduce radical new technology to leapfrog their competitors, they can likely reduce their market share losses from the 30%-40% to the 15%-20% range.*** This will require significant investment and technological risk a level beyond those employed in the A380 and 787 programs, neither of which has been without difficulties. These innovations might come after new competitors have already grabbed a big market share. The leapfrog development might allow Airbus and Boeing to regain lost share and staunch the initial bleeding.
- ***With seven rather than four major competitors, the supply/demand balance for the industry will change in favor of overcapacity.*** This will result in increased pressure on pricing in the intermediate term, and without revolutionary technology, will impact the ability of Airbus and Boeing to maintain margins in the longer term.
- ***The following charts summarize the emerging and existing competitors in the 70-149 and 150-200 seat sectors:***

Key Competitors in the 70-149 Seat Range

<p>Type: E-Jets E170, E175, E190, E195</p> 	<p>Type: ARJ21 ARJ-21-700</p> 	<p>Type: MRJ MRJ-70, MRJ-90</p> 	<p>Type: Superjet 100 S-100-75, S-100-95</p> 	<p>Type: Kawasaki YPX</p> 
<p>Manufacturer: Embraer in Brazil</p>	<p>Manufacturer: COMAC in China</p>	<p>Manufacturer: Mitsubishi in Japan</p>	<p>Manufacturer: Sukhoi in Russia</p>	<p>Manufacturer: Kawasaki in Japan</p>
<p>Size: 70 to 110 seats</p>	<p>Size: 70-100 seats</p>	<p>Size: 70-92 seats with 110 seat stretch possible</p>	<p>Size: 70-98 seats</p>	<p>Size: 100-150 seats</p>
<p>Status: In production since 2004</p>	<p>Status: Production has started for 2010 EIS</p>	<p>Status: In Development Projected EIS 2014</p>	<p>Status: In Development Projected EIS 2010</p>	<p>Status: In Development Projected EIS 2015</p>
<p>Engines: GE CF-34</p>	<p>Engines: GE CF-34</p>	<p>Engines: PW1000 GTF</p>	<p>Engines: PowerJet Sam146</p>	<p>Engines: not specified</p>
<p>Orders: 554 delivered with backlog of 328</p>	<p>Orders: 248 Launch: Shanghai Air</p>	<p>Orders: 75 Launch: ANA</p>	<p>Orders: 149 Launch: Aeroflot</p>	<p>Orders: Not yet launched</p>
<p>Outlook: New technology engines on competing aircraft will result in need to upgrade program within first 10 years of production</p>	<p>Outlook: Aircraft will compete for large domestic market in China against Western aircraft, unlikely to sell outside of China due to lack of support.</p>	<p>Outlook: Announcement of one-year delay will not impact domestic success with program, but lack of support infrastructure may inhibit international sales.</p>	<p>Outlook: This plane has little Russian content, and will be viewed more favorably than past Russian types internationally with Alenia support network.</p>	<p>Outlook: A step up from the MRJ from Japan to compete with the C-Series. This aircraft could grow in size as development continues to 150 seat class.</p>

Key Competitors in the 70-149 Seat Range (Cont.)

<p>Type: Cseries CS-110, CS-130</p> 	<p>Type: B-737 -600, -700</p> 	<p>Type: A320 Family A318, A319</p> 	<p>Type: CRJ -700, -900, -1000</p> 
<p>Manufacturer: Bombardier in Canada</p>	<p>Manufacturer: Boeing in USA</p>	<p>Manufacturer: Airbus in France</p>	<p>Manufacturer: Bombardier in Canada</p>
<p>Size: 110-149 seats</p>	<p>Size: 110-137 seats</p>	<p>Size: 110-124 seats</p>	<p>Size: 70-100 seats</p>
<p>Status: In Development Projected EIS 2013</p>	<p>Status: In Production</p>	<p>Status: In Production</p>	<p>Status: -700, -900 in Service, -1000 EIS 2010</p>
<p>Engines: PW1000 GTF</p>	<p>Engines: CFM56-7</p>	<p>Engines: CFM56-5 or IAE V2500</p>	<p>Engines: CF-34</p>
<p>Orders: 50 Launch: LH for Swiss</p>	<p>Orders: 1,621 Delivered: 1,068</p>	<p>Orders: 1,606 Delivered: 1,264</p>	<p>Orders: 619 Delivered: 503</p>
<p>Outlook: In a unique size range and launching new technology GTF engines, this aircraft is a game changer in this segment due to superior economics.</p>	<p>Outlook: A mainstay of airline fleets, the -700 is a best seller while the -600 languishes. RS aircraft moved out to 2020 as RE model is considered for interim.</p>	<p>Outlook: A mainstay of airline fleets, the A319 is a best seller while the A318 languishes. RS aircraft moved out to 2024 and RE aircraft will be launched soon.</p>	<p>Outlook: A long stretch of the initial 50 seat RJ, the CRJ-1000 will be efficient but comfort is not a long suit with its narrow cabin.</p>

Key Competitors in the 150-200 Seat Range			
<p>Type: MS-21 MS-21-200,-300, -400</p> 	<p>Type: C919 -200,-300</p> 	<p>Type: Boeing 737 -800, -900</p> 	<p>Type: A320 Family A320, A321</p> 
<p>Manufacturer: UAC in Russia</p>	<p>Manufacturer: COMAC in China</p>	<p>Manufacturer: Boeing in USA</p>	<p>Manufacturer: Airbus in France</p>
<p>Size: Range from 150 to 212 seats</p>	<p>Size: Range from 156 to 190 seats</p>	<p>Size: 130-190 seats</p>	<p>Size: 124-190 seats</p>
<p>Status: In development Projected EIS 2016</p>	<p>Status: In development Projected EIS 2016</p>	<p>Status: In service since 1998</p>	<p>Status: In service since 1989</p>
<p>Engines: PW1000G or RR or IAE V2500</p>	<p>Engines: PW1000G or LEAP-X or V-2500</p>	<p>Engines: CFM-56-7</p>	<p>Engines: CFM56-5 or V2500</p>
<p>Orders: Not Yet Offered</p>	<p>Orders: Not Yet Offered</p>	<p>Orders: 3,397 Deliveries: 1,800</p>	<p>Orders: 4,812 Deliveries: 2,721</p>
<p>Outlook: Aircraft will replace Tu-154 in Russian market, and with new technology, UAC hopes for 50% of production for export, a difficult challenge.</p>	<p>Outlook: A domestic alternative to A320 and 737 families for the domestic market. Export success not likely as China develops first modern programs.</p>	<p>Outlook: A mainstay of airline fleets, The 737NG is a best seller. With replacement now after 2000, likely re-engining program in near term.</p>	<p>Outlook: A mainstay of airline fleets, the A320 and 321 remain popular, but re-engining is likely with replacement not available until 2024.</p>

Key Competitors in the 150-200 Seat Range (Cont.)			
<p>Type: A320RE, A321RE</p>  <p>Manufacturer: Airbus in France</p> <p>Size: 124-190 seats</p> <p>Status: Re-engineing Projected EIS 2014-15</p> <p>Engines: PW1000GTF, LEAP-X, IAE? RR?</p> <p>Orders: Not Yet Offered</p> <p>Outlook: A320 needs an upgrade and re-engineing and winglets are planned to leap-frog 737NG with superior economics prior to new model in 2024</p>	<p>Type: 737-800RE, 737-900RE</p>  <p>Manufacturer: Boeing in Seattle</p> <p>Size: 124-190 seats</p> <p>Status: Re-engineing Projected EIS 2014-15</p> <p>Engines: LEAP-X</p> <p>Orders: Not Yet Offered</p> <p>Outlook: Case for re-engineing makes sense for carriers seeking 15% fuel burn improvement in near term, while new technology postponed to 2020.</p>	<p>Type: A30X (A320RS)</p>  <p>Manufacturer: Airbus in France</p> <p>Size: 150-225 seats</p> <p>Status: Under study Projected EIS 2024</p> <p>Engines: Not Selected UDF technology?</p> <p>Orders: Not Yet Offered</p> <p>Outlook: Airbus seeks 40% improvement over today's aircraft with new design incorporating aerodynamics as well as engine technology for EIS in 2024</p>	<p>Type: 7X7 (737RS)</p>  <p>Manufacturer: Boeing in USA</p> <p>Size: 150-225 seats</p> <p>Status: Under study Projected EIS 2020</p> <p>Engines: Not Selected UDF technology?</p> <p>Orders: Not Yet Offered</p> <p>Outlook: If fuel prices continue to rise, radical design innovations will prevail to gain additional 20% Savings over 2015 era competitors from Russia and China</p>

Introduction

This report reviews commercial aerospace programs under development in Brazil, Canada, China, Japan and Russia. Politicians have decided that their nations are better off if a substantial commercial aerospace economy develops. This means in each of these countries, commercial aerospace programs have started to earn “national champion” status.

Commercial aerospace programs are increasingly politically driven. Were these programs to be based on viable business cases justified under the harsh sun of real competition, it is unlikely many would survive. The world’s biggest established commercial aerospace suppliers are Boeing in the United States and Airbus in the European Union. A recent World Trade Organization (WTO) ruling has highlighted that even at this vaunted level, state support is an ongoing reality.

Despite obvious issues such as the WTO opposition to national favorites, we do not see any of these programs being curtailed. Commercial aerospace programs are attractive because of their complexity. These programs demand large supply chains of parts and each firm within the supply chain employs highly skilled people. Therefore, nurturing and developing a commercial aerospace program is politically attractive. Once a nation has a viable commercial aerospace program they have the ability to create spinoff industries.

The term “offset” has become increasingly popular when airlines buy aircraft. “Offsets” is a loaded term; as offsets are prohibited under WTO rules. Semantics aside, it is clear offsets exist. Within the sales of defense related equipment, there is an association that deals with offsets (Today’s WTO rules do not apply to defense.) It is quite likely that these offset programs started in defense deals. The Defense Industry Offset Association's 65 member companies represent virtually 100% of the defense/aerospace prime contractors in the United States. The association's purpose includes “educate its members about the practice of offsets and related business functions such as counter-trade, joint venture formation, international finance, and transactional analysis”.

Emerging Markets

This report focuses on programs within five countries. Of these, Canada and Russia have the oldest commercial aerospace programs. Nonetheless, these nations and their programs might rightfully be termed emerging markets. With gestation periods over decades, these nations have seen their aerospace firms grow from rudimentary aerospace companies into firms capable of designing and building sophisticated aircraft. These programs are also emerging in the sense that they are now offering larger commercial transports and are nibbling, for the first time, at the heels of programs at Airbus and Boeing.

Canada’s Bombardier started out as a Skidoo manufacturer that added rail and aerospace as it became a conglomerate. It would be tough to believe that all this activity took place without at least a wink and a nudge from Ottawa, and in fact, the government of Canada provided economic support for the development of the Canadair Regional Jet. Russia’s programs all started out under Soviet communism.

Interestingly under Soviet times, there were many design bureaus involved in designing and running airliner and freighter programs. After the collapse of communism, these organizations struggled and recently under President Putin's watch, they were amalgamated into one firm.

The newer players, Brazil and China, respectively, also started out with friends in high places. Indeed, Embraer's history goes back to the 1940's, when the Brazilian government created the de Pesquisas e Desenvolvimento (Research and Development Institute).

By comparison, China's current state sponsored industry was re-organized in 2008, when the Commercial Aircraft Corporation of China Ltd. was created with its primary shareholders including the Chinese central government, the municipal government of Shanghai, AVIC I and AVIC II. AVIC stands for "China Aviation Industry Corporation", and was created in 1999 by splitting the state-owned China Aviation Industry Corporation (AVIC) into AVIC I and AVIC II. AVIC I was historically focused on large planes such as bombers, medium commercial planes, or fighter planes, while AVIC II was focused on smaller planes and helicopters. Typically of China's programs, these firms are opaque. The only item known with certainty is that they are entirely state funded, and that China's aviation industry was created during the Korean War era in 1951.

Japan is yet another variation, reentering the commercial arena after an absence of 32 years. The NAMC YS-11 was the last commercial airliner developed by a Japanese company, with a production run from 1962-1974 and just 184 built. There were a small number of exports.

Mitsubishi has developed the MRJ regional jet seating 70-96 passengers and more recently indicated interest in increasing capacity to 100 seats or slightly more. Kawasaki announced plans to develop a 150-seat airliner, a size directly competitive with the Airbus A320 and Boeing 737-800. Both Japanese companies are industrial partners in the Boeing 787 program.

The sudden proliferation of regional jet designs and the pending launches of 150-seat jets has questionable business rationale, to be charitable. Airbus views the coming 70-130 seat segment competition as a "bloodbath." The world market cannot support the large number of products in development or planning. National pride often overtakes good business sense, however, and in the end something will have to give: either failure of some of the new ventures or disappearance of the legacy manufacturers from the commercial airplane market. Such a prospect may seem outrageous but it is useful to recall that while Douglas Aircraft Co. and Lockheed's commercial division dominated the world markets for decades; neither exists today. Britain too, had a number of commercial aircraft producers; all ceased to exist. France, Germany and Holland also had commercial aircraft companies and none exists today except perhaps as a predecessor of Airbus.

We deem it possible that today's Big Four aircraft companies—Airbus, Boeing, Bombardier and Embraer—are not only transferring technology that creates these emerging competitors, but that taken to the extreme, these practices could eventually lead to one or more of these legacy companies withdrawing entirely from commercial airliner production. We are most concerned about Boeing. The aggressive practice of outsourcing advanced technological elements of the 787 has not only proved

disastrous in execution, but has given others access to its intellectual property. Mitsubishi is quite open in saying its new airplane program has directly benefited from the 787 partnership. Boeing has agreed to provide marketing and consulting assistance to Mitsubishi and Sukhoi, a practice that not only increases the “technology” transfer but which also results in transferring marketable business skills as well.

Boeing is not alone. Airbus increasingly is proceeding down this slippery slope. To varying degrees, the Western aerospace companies as a whole are guilty of these practices. More detail is provided in the Technology Transfer section.

If these trends continue, the threat to the Western aerospace industrial base is real. It is not too late to pull back, but that window of opportunity is rapidly closing.

WTO Issues

The September 4th findings contained in the WTO Interim Report in the complaint by the US Trade Representative (USTR) against Airbus launch aid, tax breaks, research and development support and other financial issues should have application in aircraft programs underway in WTO member countries (all but Russia). The Interim Report, which has not been made public at this time, is widely reported to have found that Airbus illegally benefitted from financial aid on a number of fronts. It is generally accepted that Airbus improperly profited from R&D funding; and that all, or nearly all, A380 financial and infrastructure aid was improper. Members of the US Congress who are Boeing supporters claim that launch aid for every Airbus airliner has been found to be illegal. Airbus supporters understandably dispute these sweeping characterizations.

Until the WTO releases its 1,000 page report, which will be sanitized of commercially sensitive information, speculation will continue to run rampant. The WTO is expected to issue its next Interim Report in 1Q-2Q2010 in the European Union’s complaint against alleged “illegal” subsidies provided to Boeing. Principal allegations include improper tax subsidies by several states; improper benefits from R&D work from NASA and the Defense Department; and improper benefit of some infrastructure support.

Appeals by both parties are expected once a Final Report is issued: a process expected to continue until perhaps 2012-2013. The USTR also plans to challenge emerging government support for the Airbus A350, now in development. Airbus has said that the A350 support will comply with WTO rules and in any event, its surrogates claim that launch aid itself is not inherently illegal as long as it is structured in conformance with the WTO guidelines.

Airbus and its parent EADS have already signaled a willingness to negotiate a resolution in the WTO dispute rather than dealing with an agonizing, drawn-out process of appeals. Until the EU-Boeing findings are issued, however, there is no reason for the US to agree to negotiations.

Furthermore, Airbus CEO Thomas Enders believes a bilateral agreement between the EU and the US to resolve the complaints is insufficient because it will not include the emerging markets. He calls for an entirely new global agreement on state aid to aerospace industries that includes the emerging markets.

We concur with his view.

The governments of all the new airplane programs provide financial support of various kinds and levels. How will the WTO finding in the Airbus case, and eventually the Boeing matter, affect the emerging competitors?

Canada and Brazil previously were embroiled in a WTO dispute in which each country accused the other of providing illegal export subsidies in support of Bombardier and Embraer regional jets. The WTO found in favor of both complaints, which provided a way for Canada and Brazil each to impose tariffs on airplanes or other products. In the end, neither country did so.

But state loans have come up again because of Canadian and UK support for Bombardier's CSeries. The European Commission approved £113.7 million (\$187.6 million) in repayable advances in June. The UK Government is also providing money to Bombardier's Belfast operations to support the company's development of composite wings for the CSeries. The Canadian national and Quebec provincial governments have also pledged aid.

Embraer raised concerns earlier this year, challenging these loans again. Bombardier is "confident" the governments will prove the loans fall within World Trade Organization regulations. Importantly, Embraer is not alone in raising questions about Bombardier's CSeries funding. Last year the US Trade Representative vowed to scrutinize any state aid provided to Bombardier to support CSeries development.

For Embraer, the matter is especially critical. Its E-Jets are still new to the market and are far superior to the aging Bombardier CRJ series. If Bombardier is able to produce the CSeries, Embraer may be forced to create a new jet well before the return on investment of the E-Jets is achieved.

We don't, however, believe there will be any meaningful affect on the development funding for the emerging airliners.

- The WTO findings have no effect until they become final and all appeals are considered and disposed of. This will be years, during which time the development of new jets will proceed.
- Countries may choose to effectively ignore the WTO findings. The WTO has no enforcement power; imposition of tariffs is left up to the countries themselves. If the countries choose not to impose tariffs (as in the case of Canada vs. Brazil in the regional jet case), life goes on.
- Tepid efforts by the losing country to comply may result in additional WTO complaints that drag things on for years. The European Union successfully challenged tax breaks authorized by the US under the Foreign Sales Corporation (FSC, pronounced "fisk") legislation. Boeing was a prime beneficiary of these breaks (as was Microsoft and companies in other industries). Congress revised the law several times, but the EU wasn't satisfied. The WTO recently revisited this issue for the seventh time.

- Even if a complaint is upheld, tariffs may not be imposed at all (as noted above) or they may be imposed on an entirely unrelated industry.

In essence, the WTO's decisions are toothless and largely a waste of everyone's time and money. Compliance is effectively voluntary and any tariffs are entirely optional. Public relations and political points are scored, making these the principal benefits of a WTO ruling.

With this being the case, the countries with emerging airplane programs have no incentive to voluntarily follow any WTO finding, and in the case of Russia, not a member of the WTO it becomes totally meaningless. China and Russia in particular will do whatever is in their own best interest regardless of what the world thinks. While the Western countries are less brazen, their practices indicate a similar worldview.

The 100 seat watershed

The RJ programs these five nations have on offer, at present all top out at approximately 100 seats. This is a watershed number. Fewer than 100 seats is generally regarded as small. But once one goes over 100 seats, it is a short jump to the smallest Airbus A318 (~107 seats) or Boeing 737-600 (~110 seats). Aircraft in this category (over 100 seats) are then swimming in deeper waters with the biggest industry players. Several current programs now encroach on the 100 to 150 seat market. This explains, in part, why Airbus and Boeing are moving toward larger aircraft and ceding the smaller market. There are a variety of other reasons², too, but for purposes of this report; we confine our discussion to the emerging competitive landscape.

Boeing made it clear at the 2008 Farnborough Air Show that it has little interest going forward in the under-150 seat segment. Although Scott Carson, then-president of Boeing Commercial Aircraft, declined to say *definitively* that Boeing will give up this market in the future, the signal was pretty clear that this was the current thinking.

This presents an interesting dilemma for Boeing in the future. Southwest Airlines has ordered more 737s than any other customer since Southwest began operations in 1971. This airline launched the 737-300, 737-500 and 737-700. These are all at the small end of the 737 family, and, in Southwest's configuration, have well below 150 seats. Southwest doesn't need, nor probably does it want, an airplane with the capacity of the 737-800. Not only does Southwest's load factor typically run 5-7 percentage points below the US legacy airlines, making it too large for the carrier, but an airplane the size of the 737-800 would also slow Southwest's well-known short turn-times. Is Boeing truly going to lose this valuable customer by foregoing a 130-seat airplane?

We shall see.

² Environmental, air traffic control constraints and airport capacity constraints are causing Airbus and Boeing to trend toward larger aircraft.

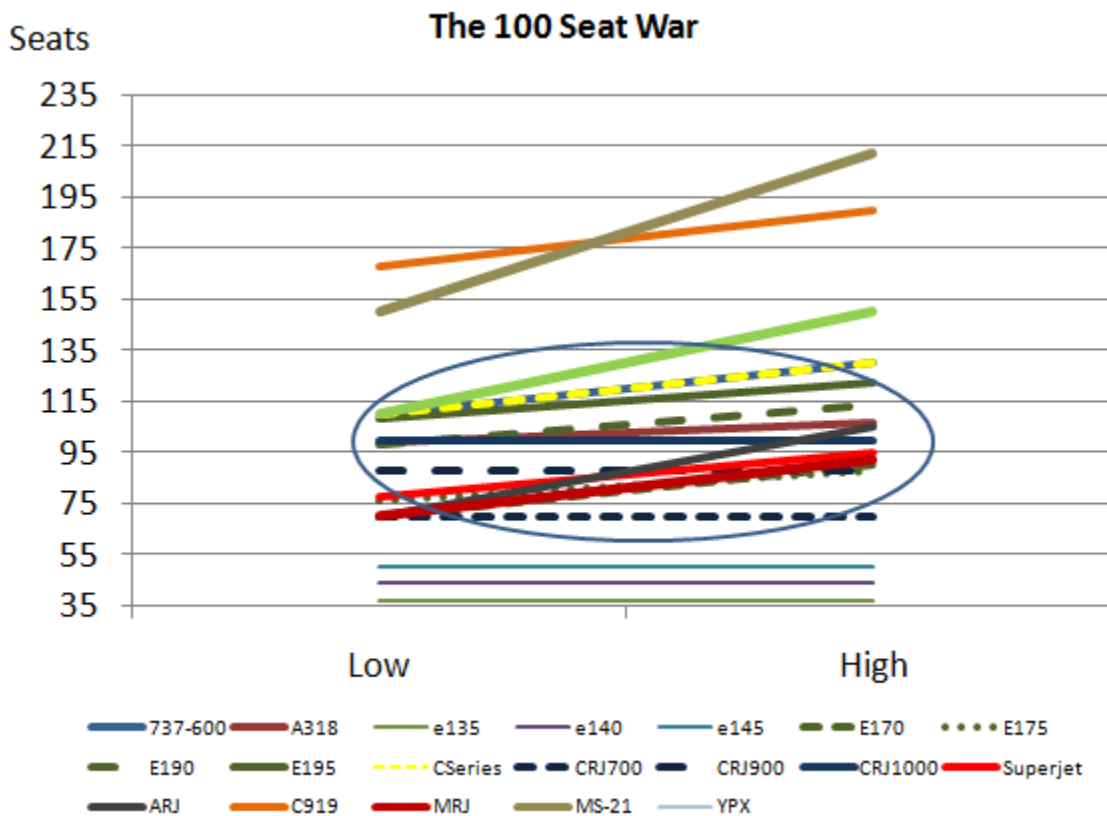
The chart on the following page illustrates just how crowded this market is becoming. Note how the CSeries exactly fits over the size of the Boeing 737-600. Note also how the players in this space are all offering ranges of seats as each plane is a family. Crowded indeed, as Bombardier has two offerings in the space - the CSeries and the CRJ1000. China has one, the ARJ21. Russia has one, the Superjet. Brazil's Embraer offers four models in this bracket. Japan plans to offer two models.

The market used to be so simple – there was the A318 or the Boeing 737-600 to choose from. However, within two years the 100-seater market has become crowded with 10 options; making it, without exaggeration the most crowded segment of the airliner market. This is the sector that can be expected to be the most brutal in terms of deals. The newer entrants will have to trade hard to win sales – we expect to see China lean hard on its domestic airlines to buy local. Similarly Russian airlines can expect “encouragement” to buy locally. Furthermore, we expect to see Chinese and Russian aircraft popular in Africa as favorable export credits make aircraft attractive. Airbus and Boeing will be disadvantaged by government buy-domestic-first policies.³

As each nation and other countries within its sphere of influence leans on its local favorite, the market is restricted for the other vendors, increasing the cutthroat environment. There is little doubt this segment will become the most fascinating to observe over the next decade.

Profitability in the below 100-seat market has always been challenging. The proliferation of competitors in this market segment makes no financial sense. Therefore, it is not beyond the realm of possibility that the ARJ21, the Sukhoi 100 and the Mitsubishi MRJ might actually be airplane programs that will eventually become the prototypes for more profitable 100-150 seat and 150-200 seat aircraft these government-supported companies have already indicated interest in pursuing.

³ This illustrates why the “Buy America” policy advocated by some Members of Congress is treading on hazardous ground.



Given that profits rise as aircraft get bigger, there is great incentive to grow existing programs. Consequently, China has shown its ARJ21 aircraft (70 to 100 seats) as a start to its aircraft industry. The C-Series is expected to have up to 130 seats in standard two-class configuration – this competes with the A319 and 737-700. A stretch version could provide additional competition, and as shown by the CRJ series, Bombardier is a master at stretching an aircraft.

Embraer has indicated that its development of the KC-130 tanker/freighter for its air force is a program intended to learn how to build larger aircraft.

Similarly Russia’s Superjet is expected to have 98 seats, with a family that includes a smaller version with 78 seats. Sukhoi, the Superjet’s builder, will use this experience in transitioning to larger aircraft, and is a participant on the MS-21 program. Sukhoi is the creator of Russia’s premier fighter aircraft and consequently lacks nothing when it comes to fly-by-wire and other digital control technologies.

A key item to watch is how the new programs in these emerging aerospace nations grow. Any success will demand they move to even larger aircraft. Several programs are already moving in that direction. As engine technology drives economics, a key issue for the A320 and 737 replacement programs is whether Airbus and Boeing can technologically leapfrog these programs under development to retain market share.

The bottom line is that we have gone from two competitors in the 130-seat to 200-seat class to five overnight – with the possibility of Kawasaki and Embraer also wanting to play. Some will win, and some will lose, but most will take a strong share of their domestic markets, fundamentally changing the competitive dynamics of the industry.

Engines

Airframe manufacturers push their designs as hard as they can, continually tweaking to achieve as little as a 1% improvement in performance. The poster child for this activity is undoubtedly Boeing's 737. However, both Airbus and Boeing said they cannot replace their single aisle designs until they have better engines to work with. The goal is to secure at least a 20%-25% improvement in fuel burn.

The challenge is not unique to these two large firms. Even among the smaller 100-seat aircraft, new engines are playing a vital role in improving efficiencies. Indeed, it is in this operating class that Pratt & Whitney is launching its long awaited geared fan engine, known as PurePower. The engine has been selected to power the Bombardier CSeries and Mitsubishi RJ. Another new engine, the SAM146 that will power the Sukhoi Superjet 100 has been developed and will also have significantly lower fuel costs than prior generation engines. General Electric is revising its CFM56 engine (built with SNECMA, which also has a role on the Superjet engine) to ensure its offering remains competitive. Meanwhile Rolls-Royce, despite being very quiet about its plans, is working on an unducted fan engine and a conventional 3-stage engine, while its IAE joint venture with Pratt & Whitney is retooling its V2500 offering.

Pratt & Whitney PurePower™



Image: P&W

This is the current name for what was once known as the geared turbofan or GTF. P&W have been working on this engine since 1988. As will become apparent from this report, P&W's engine may be one of the most influential pieces in the 100-seat market puzzle. Its market timing is perfect for the emerging programs.

The engine offers a striking improvement in fuel burn over current engines as well as generating much less noise. P&W state its current PurePower engine (PW1000G) delivers a 16% lower fuel burn than the CFM-56 or the IAE V2500.

The PW1000G is approximately the size of the P&W 2000, which powers the 757. P&W has tested their PW1000G up to 40,000lbs of thrust (comparable to PW 2000), though it is aimed and will be delivered at the 24,000lb thrust bracket. Whereas the P&W 2000 has a bypass ratio of six, the PW1000G has a bypass ratio of 12. Moreover, P&W believes that with an even higher bypass ratio plus an increase in other pressure ratios, they can improve fuel burn by 22% over the current CFM-56 benchmark and be nearly competitive with the open-rotor's promised 26% SFC improvement but without the noise, weight and blade-failure issues.

As new aircraft programs evolve, the role of engines is crucial. Depending on designs, the placing of these engines can be limited. For example an unducted fan (UDF image P&W) engine cannot fit under the wing. It has to be placed on the aft fuselage, changing the weight distribution and making it necessary to rethink the positioning of wings and landing gear as well. Indeed, when evaluating the options, P&W decided to stay with a turbofan as it offers a more flexible solution with either under wing or aft installation possible.



P&W explained, in an interview for this report, that it faces three issues in making the PW1000G engine superior to a UDF engine. With its decades of experience in turboprop engines, P&W is experienced to know the challenges it faces. The first is misaligned gears – as the image (source P&W) on the right shows. The gearbox in the PW1000G is a highly complex piece of equipment leading to the second issue – lubrication. If the engine experiences a zero-G movement, regular oil flow could be interrupted. As a result, P&W added a separate oil supply system to supplement the regular lubrication, offsetting the disrupted oil flow that was revealed by Airbus on its A340-600 test bed. The PW1000G overcame these tests. The final test is variable pitch, an issue that all UDF engines have, but which does not exist on the PW1000G. Indeed, from P&W tests, its PW1000G is quieter, cleaner and more frugal than any competing engine. Consequently we believe this engine is a key component in the ascendancy of the success of these new aircraft.



When probing P&W about their plans for other programs identified by this report, the company stated it is in discussion with all the firms mentioned. For example, P&W has been selected to provide an engine on UAC's MS-21, but not as a partner with Rolls-Royce, as many expected. This means that airplane will not use the IAE engine. P&W is also in discussions with COMAC for the C919. Interestingly, Embraer's CEO has stated that his firm has 12-18 months before they have to review their E-Jets program – which indicates a re-engine program might be in the works. In our view P&W's PW1000G offers a slightly faster solution than GE's LEAP-X, which is focused on the 737. Finally, P&W are in deep discussions with both Airbus and Boeing. We believe Airbus is more likely to use the PW1000G on its A320 than Boeing will on

its 737, given Boeing's exclusive supplier agreement with CFM for the 737, but Airbus could offer the LEAP-X as well. Given that both Airbus and Boeing are sliding their replacement efforts to ~2020, P&W looks well placed to benefit. CFM originally planned to certify its LEAP-X in 2016 for EIS a year or two later; this timeline may accelerate by two years.

General Electric LEAP-X

GE, via its CFM International JV with Snecma, has developed a strong following in its CFM-56 engines. The LEAP-X (image GE) is designed as its replacement. Like P&W, GE has developed an engine sooner than Airbus or Boeing is ready to use it. However, GE's engine is too large for aircraft in the 100-seat bracket. Consequently we expect see GE use the lessons from the LEAP-X program to be transferred to the CF-34, the engine used by the Embraer and Bombardier aircraft. The latter has already committed to the PW1000G. The former is still an open program, which is likely to require a new engine to remain competitive with the CSeries.



It appears that GE is more focused on the 737 and A320 programs. GE has a lock on the 737, and the company's relationships with Boeing extend to exclusivity on the 747-8 and on certain 777 models. According to GE, the LEAP-X has a 16% better fuel burn than the current CFM-56 engine. This has been accomplished using a novel "twin annular premixing swirler" – essentially a technique that increases the amount of oxygen in the combustion chamber. This same technology is being used in the GENx engines on the 787 and 747-8. GE is also focused on matching its current CFM-56 reliability. GE has benefitted from extensive carbon fiber development on large engines. This makes it possible to use 18 blades on the LEAP-X engine rather than 24 as on the CFM-56.

In terms of bypass ratios, the LEAP-X will be at 10 compared to 6 on the CFM-56. (Note a big disparity with the PW1000G, which starts at 12) GE's UDF (image GE) has a ratio of 40 and offers 10 percentage points better fuel burn. As previously noted, these engines come with other costs, such as larger pylons and much greater noise envelopes. Depending on oil prices, GE could offer a 26% better fuel burn than the CFM-56 using the UDF technology. GE's UDF engine technology dates to the 1980s. Reports are that both Rolls-Royce and SNECMA are pursuing such technology.



To illustrate the complexity of mounting a UDF engine, refer to the images on the next page which displays the pylon size required to hold each of the engines. Though these are both GE engines, and of nominally equal size, the CFM-56 engine requires a smaller pylon and the engine fits under and ahead of the wing. In contrast, the UDF engine requires a much longer engine pylon to allow for clearance of the blades.

The longer pylons present problems from the point of view that these limit location to aft fuselage installation. They present challenges in terms of weight as well. Given that UDF engines are inherently noisier than shrouded fans, one can see how UDF solutions present difficulties. Consequently the approach that is likely to see the quickest implementation will be the PW1000G and LEAP-X. (Images GE and Planer-Spotter.com respectively)



UDF



CFM-56



Source: P&W

The UDF hurdle is best illustrated by the image on the preceding page; airplane installation under wing is a problem due to size, and the weight of these engines creates additional issues. As a result, projected cost savings from lower fuel burn may be offset by increases in cost from heavier aircraft and greater complexity.

In summary, there are pros and cons of the UDF compared with shrouded turbofans. The benefit is fuel efficiency. However it is noteworthy that most of the data we have on this efficiency is based on test cell research from the 1980s and 1990s, rather than today. The UDF hurdle is best illustrated by the image

above; airplane installation under wing is a problem due to size, and the weight of these engines creates additional issues. As a result, projected cost savings from lower fuel burn may be offset by penalties imposed by heavier aircraft and greater complexity.

Technology Transfer

The new airplane programs in Japan, China and Russia benefit from technology transfers from Airbus, Boeing, Bombardier and Embraer. This is a bold statement and one that the Big Four will deny, for this is a touchy issue. Nonetheless, it is true.

Japan's Mitsubishi publicly said its development of the MRJ benefits from the technology work it is doing on the Boeing 787. Kawasaki, another 787 industrial partner, announced plans for a 150-seat jetliner and it is naïve to think that its 787 experience won't find its way into this 150-seat aircraft.

China's ARJ21 looks like a clone of the Douglas DC-9-10 or the McDonnell Douglas MD-95 (now the Boeing 717). McDonnell Douglas assembled the MD-80/90 in Shanghai, which, while unsuccessful from a commercial standpoint, clearly gave the Chinese a crude foundation on which to build. The proposed Comac C919, a 150-190 seat jetliner, is nearly identical to the Airbus A320. With an A320 assembly plant in Tianjin, this is hardly a coincidence. Airbus and Boeing have been outsourcing component work to China for decades and the Chinese appear to have gained massively from that process.

Bombardier outsources the Q400 fuselage to China and will do so for the forthcoming advanced technology fuselage for the CSeries. Embraer has an E145 assembly plant in China, which while of dubious commercial benefit, results in additional production experience for the Chinese. A variety of suppliers outsource to China, providing additional valuable experience for China.

Airbus' Tianjin A320 assembly plant is a replica of the ultra-modern Hamburg, Germany facility. Airbus CEO Thomas Enders says there are protections in place to safeguard technology. It's a good thing, as there are published reports of at least three or four serious attempts at hacking into the Chinese Airbus system that have been thwarted. We doubt Chinese industrial snoops will give up with these attempts. In any event, China is gaining valuable production experience and knowledge from this plant that by all appearances will be utilized in the A320-look-a-like C919.

Airbus also has a joint venture with Russia for the A320 P2F freighter conversion. One can question just how much technology Russia will gain from this venture, but we believe a little bit here and a little bit there remains useful in creating and validating a viable aerospace industry.

Airbus also has a joint venture with Russia for the A320 P2F freighter conversion. One can argue how much technology Russia will learn from this venture, but we believe a little bit here and a little bit there remains useful in creating a viable aerospace industry. Airbus in September 2009 revealed that it has entered another joint venture program with the Chinese in which *research and development*, among other things, will be a component.

Boeing's industrial outsourcing of the 787 is well documented. Airbus and Boeing also are aggressive in

outsourcing engineering. Boeing used the Moscow Design Center for its 787 and 747-8 engineering (with mixed results). Boeing also outsources engineering to Spain, Italy, India and many other countries. Airbus likewise has about a dozen outsourced engineering contracts. Regardless of how strong cyber - security may be in these cases, the workers retain a certain level of knowledge in their own memories. These can easily become intellectual property thefts of civil and, more importantly, military applications. Furthermore, neither Russia nor China has a history of respecting IP ownership rights. We believe that if there is a way to penetrate cyber-security to obtain critical documents, they will be found.

Our view is by no means universally held. One noted aerospace analyst believes technology provided by Western Aerospace is unlikely to be the latest iteration, and in the case of China, the aerospace industry does not have the airframe technologies needed to match Western advances.

We don't disagree on the latter point, also held by Airbus. But we take the long view, that over the next 25-50 years, rather than just the next 5-10 years, the accumulation of knowledge and experience will even the playing field. As long as Western aerospace continues to outsource, as has been their practice, we believe that China in particular, given its national goals, can catch up.

Furthermore, none of this debate gives credit to the engineering and aerospace acumen that the Chinese develop themselves. One European aerospace company (not Airbus) informs us that its personnel have been shown Chinese capabilities in its area of expertise by AVIC. This company was impressed by the high-tech nature of the Chinese-developed expertise, which is available at a fraction of the cost of the European company.

Western technology advantages remain in aerodynamic, materials, and the level of knowledge Westerners currently have compared with the Chinese – but the “technology gap” in each of these areas is being eroded.

Lest one think we are only picking on the Big Four airframe OEMs, our concern applies to other suppliers as well, including engine-makers. GE in September 2009 announced a new joint venture in China in partnership with France's Safran that provides for the development engine components and nacelles— and for *an indigenous Chinese engine*.

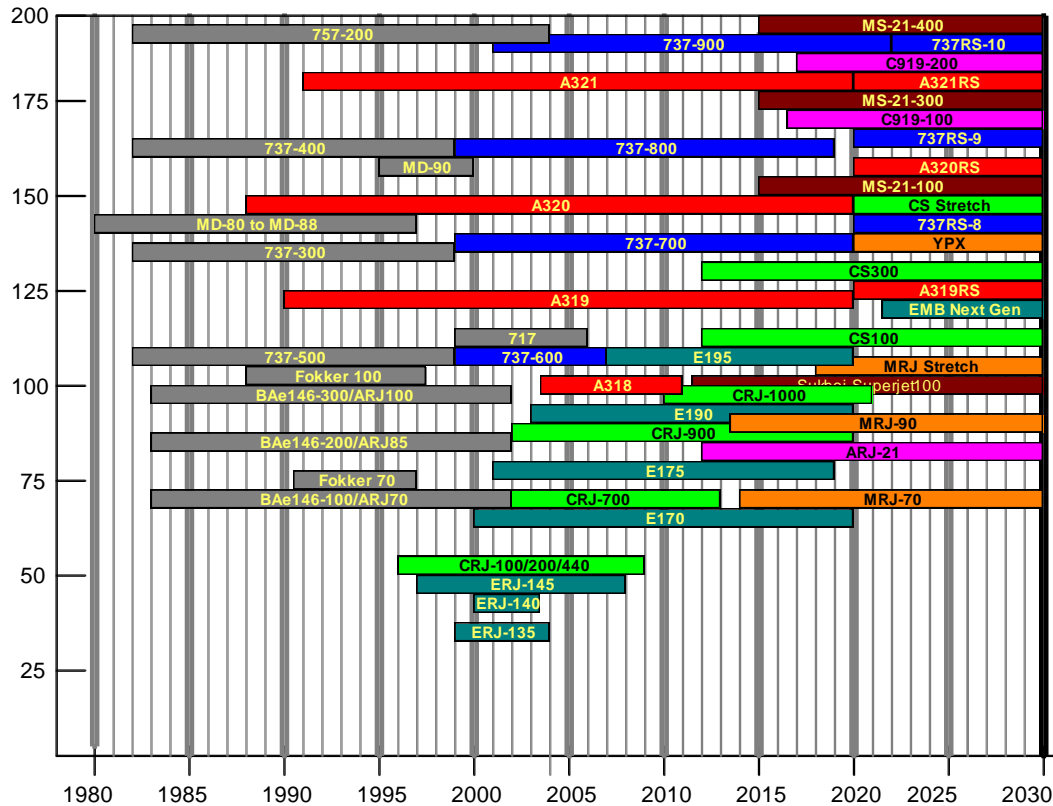
We have also raised concerns about civilian technology finding its way into military applications. One prominent US aerospace analyst, as well as at least one of the Big Four, dismisses these concerns. However, the Chinese aren't so subtle. They have openly told Western media that they want to develop dual-use civilian-military technology.

While some in the US Congress carry on about the threat to the US aerospace industrial base if the Airbus A330-based KC-30 receives the KC-X tanker contract, we find this line of thought to be hyperbole at best and demagogic at worst. The far greater threat is the willing technology transfer undertaken by the Big Four in the name of strategic marketing, sales, relationships and cost cutting. The Big Four are creating their own commercial competitors and risking technology transfer to military applications.

These same Members of Congress who whine about an American ally and member of NATO possibly getting the KC-X contract are silent about these threats to the American aerospace industry.

Increasing Competitiveness

NARROW-BODY JET AIRCRAFT PROGRAMS BY NUMBER OF SEATS AND YEARS PRODUCED



The chart illustrates the changing competitive outlook for trunk-line jets with more than 100 seats. In the 1980s, Boeing, McDonnell Douglas Corp. and Airbus provided a competitive triumvirate, which after Boeing’s 1997 acquisition of MDC became a duopoly. Between 2000-2013, only Airbus and Boeing produced or will produce commercial jet aircraft in the 100- to 200-seat segment. By 2020 Comac in China, UAC in Russia, Bombardier in Canada, Embraer in Brazil and Mitsubishi or Kawasaki from Japan will join Airbus and Boeing in the 100- to 200-seat range. The Big 2 have already become the Big 4 with Bombardier and Embraer. If emerging competitors’ ambitions are achieved -- a big “if” --the Big 4 will become the “Competitive 7” as China, Russia and Japan join the marketplace with new offerings.

In the remainder of this report, we examine the current and planned programs from each competitor, their competitive position, and the outlook for each country and manufacturer, as well as projecting the new competitive landscape in commercial aircraft through 2030.

As the chart above illustrates, this market segment is going to be the most crowded space in commercial aerospace going forward. For many of the players, this is their going to be their apprenticeship for building skills for future programs. Where these new firms and their skills go next is anyone's guess. But we believe we are seeing the building blocks being laid that will certainly disrupt, if not fundamentally change, the commercial aerospace industry.

Airbus and Boeing: Meeting the Competition

We have discussed the crowded market and Technology Transfer threats. We've identified the current intent of Airbus and Boeing to cede the markets below 150 seats. We noted that the A320 and 737 replacement aircraft are now anticipated in the 2020-2024 period.

If the emerging aircraft were limited to fewer than 130 seats, neither Airbus nor Boeing would have much to worry about pending their replacement aircraft. But as we have seen, the Chinese, Japanese and Russians have ambitions in the 150 to 200-seat market with project EIS dates beginning in 2016.

While we have doubts that the proposed EIS dates for some of these programs will be achieved, absent definitive reasons to the contrary, we must assume them to be valid. We also have doubts about the viability of these first efforts outside their home markets, but the potential loss of sales by Airbus and Boeing to these home markets is not insignificant.

With 150-seat competitors emerging as early as 2016 and Airbus-Boeing replacement EIS shifting to 2020-2024, there is potentially a significant gap during which the A320 and 737 families will become economically uncompetitive.

We don't believe that Airbus and Boeing will "sit still" and simply let China, Russia and Japan develop 150-200 seat airliners that provide ~15% better operating economics at a lower sales price. Rather, based upon solid information, we believe it a near certainty that Airbus and Boeing will re-engine the A320 and 737 families to serve as interim solutions to airline demands for replacement "now". Thereby increasing the shelf life of their designs and blunting the impact of the emerging competitors.

Here is our reasoning:

- Influential airlines such as Southwest, Continental, Air France-KLM, Lufthansa and American are making it clear to Airbus and Boeing that they do not want to wait 10-15 years for an entirely new replacement airplane for the A320 and 737 families. That is an unacceptable wait for a major step change in operating and maintenance costs.
- Southwest in particular has been very vocal that it needs a solution that at least is 10% better on operating costs "now." This necessarily infers a re-engine solution rather than an entirely new airplane. Other carriers, customers to both OEMs, likewise seek a sooner-than-later improvement that is far more than the incremental 1%-2% steps currently proposed by Airbus in its A320E program launched in 2005-2007; and the 737 enhancements announced April 28,

2009, with the CFM-56 Evolution and aerodynamic improvements. Southwest expressed its disappointment with the 737 enhancements as insufficient.

- Lufthansa selected the Bombardier CSeries for its 100- to 130-seat solution, with an EIS scheduled for 2013. Equipped with the new PW P1000G Geared Turbo Fan, the Lufthansa analysis determined on an NPV basis the airline will save hundreds of millions of dollars by acquiring the CSeries.
- Airbus and Boeing maintain that what we nickname the “40% Solution” is not going to be available until perhaps 2020 or beyond. The “40% Solution” term is a pick-up from the Airbus goal of a 40% improvement in operating costs outlined during its Airbus Innovation Days in May 2009. This is an innovation set that will encompass dramatic improvements in engine Specific Fuel Consumption (~25% for an Open Rotor, ~16% for the PW P1000G, CFM LEAP-X or RR 3-Stage engines) plus airframe (a moving target), plus better fuel performance (some biofuels have shown better SFC attributes than fossil fuels). In addition navigation improvements (the FAA’s Next Generation ATC, Europe’s equivalent) and Required Navigation Performance (RNP), now in its infancy in the US with carriers such as Alaska and Southwest add to potential savings. The aggregate goal is 40% operating costs improvement, which Airbus believes won’t converge until the 2020 decade. Boeing and Airbus, in rare cooperation, are devoting a great deal of resources to the navigation/ATC issues.
- The timing of technology convergence slips further and further to the right.
- Airbus and Boeing have been evaluating re-engine solutions since at least 2008. When replacement airplanes were anticipated as early as 2013-15, these solutions made no sense. As program delays on flagship airplanes at both OEMs eat up R&D money and penalties are due customers, billions of dollars for A350 R&D and multi-billion dollar pension plan payments that are due in the coming years at Boeing, cash flow becomes a problem to launch yet another entirely new airplane program at both companies. Boeing also faces the decision of whether to upgrade the 777 or design an entirely new airplane to meet the A350 threat. The last thing Boeing needs is yet another new airplane program if an acceptable interim solution can be found for the 737.
- Boeing CEO Jim McNerney told a Morgan Stanley Industrial Unplugged conference September 2, 2009, that the business case for a re-engined 737 has proved to be more compelling than it was previously thought. He further indicated the R&D for a derivative airplane is 20%-40% that of an entirely new airplane. Given the Boeing cash flow challenges because of the 787, 747-8 program delays and penalties and pension fund requirements, we certainly can appreciate this sentiment even discounting the growing market pressures for a sooner-than-later solution and converging technologies later-than-sooner.
- Boeing has an exclusive supplier agreement with CFM International to power the 737, and based also on public statements, it appears that Boeing is not interested in a 737 GTF product. CFM’s

LEAP-X is being designed with an entirely new airframe in mind and a 2016 engine certification (which would precede an airframe-engine combination by a year or two). However, CFM appears ready to accelerate and refine the LEAP-X development to meet a 737 application and an EIS of 2014-16. These will be critical questions for Boeing.

- A LEAP-X engine is targeted for a 16% SFC gain. After application on an existing airframe such as the 737, the operational performance improvement may be in the 14%-15% range, significantly better than the Southwest target of 10%-12%.
- Airbus is faced with an aging A320 family. A leading-edge airplane when it was introduced in 1988, it is an over-statement to suggest Boeing eclipsed the A320 with the 737 Next Generation refresh in 1994—the 737NG was a catch-up airplane as the A320 eclipsed the 737 Classic—but it is fair to say that the A320 is an aging dowager. Airbus will launch an A320 winglet program with a 2012 or 2013 EIS, providing a much-needed boost to operating efficiency. The winglets will be offered as an option and may or may not be a retro-fit, depending on some technical decisions that remain to be made at this writing. A re-engine program will provide the ~15% gain needed to be an interim answer to the 40% Solution. Airbus is proceeding with a winglet program update for the A320 family, with the A321 the first beneficiary. The winglet will reduce fuel burn by 2%-4%, depending on some engineering details to which remain confidential.
- While Airbus tested the P&W GTF on its A340-600 test bed, Airbus is holding discussions with P&W, CFM, Rolls-Royce and International Aero Engines about a re-engineing program for the A320 family. The former three are developing their own more traditional, if advanced technology, engine solutions. CFM and RR are also developing Open Rotor engines. The latter, offering ~26% SFC improvement, in all probability are part of the 40% Solution in the 2024 period, at best.
- P&W believes it could have a 737/A320 sized GTF available within four years of commitment, at an R&D cost of \$1 billion (estimated in 4Q2008).
- Airbus currently plans to make an RE decision by the end of 2010. Boeing, in all likelihood, will need to be on a similar schedule.
- Airbus is known to believe that any re-engine program needs 7-8 years of sales to amortize R&D costs. Thus, any RE EIS of 2014-15 for either Airbus or Boeing means that an RE will have life to 2022-23—which happens to fit nicely in with the 2024 EIS for an A320 replacement identified by Airbus COO-Customers John Leahy at the Airbus Global Market Forecast unveiling September 17, 2009.

What does all this mean?

It means that Airbus and Boeing, with modified and re-engined aircraft, can counter the projected 2016 EIS of the Comac C919, UAC MS-21 and any other emerging competitor which have targeted EIS dates of

2014-2016. The advantages of these new entrants over the current A320/737 families of these new products lie in the assumed engine selections (GTF, LEAP-X, RR 3-Stage) and a lower list price. However, the emerging competitors lack the airframe and navigation technology currently available to Airbus and Boeing that would make them a true technological leap. Nor do they have the R&D resources currently available to Airbus and Boeing to design advanced airframes that are presumed to be tested and available in the 2020 decade.

With benefits of commonality and a large installed base, Airbus and Boeing could, via re-engining programs, fend off new competition until radically different technologies can be introduced with minimal disruption to airline operations. Without significant discounts, the MS-21 and C919 will find it difficult to penetrate existing Airbus and Boeing customers outside their home countries.

Thus, the gamble for Airbus and Boeing is to match the emerging competition's 150-200 seat design with an RE program and use the next 7-8 years to develop the convergence of technologies necessary to achieve the 40% Solution. That solution in the next generation of aircraft will leapfrog the emerging airplane programs, placing them in a significant competitive disadvantage once the replacement airplanes enter service in the 2020-2024 timeframe. Even the announcement and promise of those aircraft will have an impact on competitive sales, as demonstrated by the Boeing 787 order book.

Brazil

Embraer – a brief history

We have chosen to include a brief history of Embraer because it represents a model of how a third-world country can develop a successful aviation industry. It is also particularly important since China plans to emulate the Brazilian business model as it develops its aviation sector.

This company has been highly successful in developing ever more sophisticated and larger aircraft. Starting out in 1973 with 19-seater turboprops, Embraer built a successful business supplying feeder airlines around the world with inexpensive and reliable aircraft. Starting in 1973, with the Bandeirante (image Exeternemories.com), Embraer went on to sell 500 of these aircraft to customers in 36 countries.

In August 1974, Embraer established a relationship with Piper Aircraft to assemble many general aviation products by license, including the models Cherokee, Seneca, and Navajo. The lessons were learned well. A successor to the Bandeirante ran into problems. Starting with a fresh design, Embraer developed 30 seat aircraft in 1985 that was called the Brasilia (image travel.webshots.com). This was a success; 350 were sold and the aircraft found many customers among regional airlines in the United States.

But Embraer continued to find projects and cooperative partners overseas. Working closely with its big customer (the Brazilian air force) it built trainers under license (MB-326) and also developed the fine Tucano, a turboprop trainer/ground attack aircraft. In 1981, building on its relationship with Italy's Aermacchi, the MB-326's creator, it started the AMX fighter program. Meanwhile Embraer had also been developing a highly successful agricultural crop sprayer, the Ipanema (image Embraer). This aircraft has sold over 1,000 copies and is still produced. Clearly Embraer made clever moves, cooperating with partners on projects where it needed access to far greater experience. Not every project was a success.



Embraer reached a tad too far when in 1990 it launched a 19-seat aircraft called the CBA-123 (image Embraer) Vector with a partnership in Argentina. . This aircraft used reverse thrust turboprops and advanced digital flight and engine controls. The CBA-123 should be regarded as one of the most influential projects undertaken by Embraer. Unfortunately, the project flopped, but Embraer used the experience to learn about more technologies – thus turning its financial loss into an opportunity to add to its internal intellectual property Demonstrating tremendous maturity, the company developed a highly advanced aircraft only to see it fail economically – while technically it met its design goals.



As a study of the designs of the Embraer aircraft mentioned so far demonstrates, each design built on the previous model. Anyone looking at the CBA-123 and the ERJ145 that came next can see the design resemblance. However, before the ERJ145 (image Embraer) came to fruition, Embraer suffered large losses as government contracts shrank with the end of the Cold War. The company saw employment numbers drop from 1990's 12,600 to 3,200 in 1994. Through this significant disruption, Embraer worked on its 50-seater ERJ145. Fortunately Embraer had demonstrated its ability to “work well with others”. Its alliances were widespread in the United States. These relationships ensured Embraer had access to technologies even as it scrambled with limited internal financial resources.



ERJ Series

The ERJ145 was announced in 1989 and entered service in 1996. The ERJ essentially is a stretched Braslia fuselage with turbofans and a new wing derived from the CBA 123. Embraer quickly created a product family with the ERJ145 seating 50 passengers, the ERJ140 seating 44, and the ERJ135 seating 37.

Embraer quickly turned the ERJ design into a platforms for the Brazilian air force as AEW (image Embraer) aircraft. It was also used as a core design for its popular line of business jets. This was a smart move, and Embraer weathered its early 1990 decade downturn well. Over 1,000 aircraft of the ERJ family have been delivered.



This series of aircraft first started serving airlines in 1996. The first customer for the ERJ was ExpressJet,

which uses the aircraft as Continental Express in the United States. ExpressJet is the largest operator of the ERJ 145, with 270 in service. Next biggest operator is American Eagle, which affectionately calls their 206 aircraft “Jungle Jets”.

With the arrival of the ERJ, Embraer changed its competitive focus from SAAB to Canada’s Bombardier. Whereas Bombardier took a business jet and stretched into a regional jet, Embraer went the other way, taking a regional jet and turning it into a business jet. Both companies have been able to exploit economies of scale in this process. Between them they essentially own the 30-70 seat small regional jet market.

Embraer decided to try its luck in China. Working with Harbin, Embraer decided to have the Chinese build their ERJ as a means to access the rich market of China. However, like McDonnell Douglas before, it has failed to realize significant benefits. In fact this decision is odd, because of all companies in the aerospace world; Embraer is among the most qualified to realize what really was going to happen in China. Because just as the Brazilians learned well from their teachers at low cost, they ended up training their own competitor.

Embraer, despite its reliance during its early years on state largesse, has proven to be a steady producer of aircraft, in that its path appears deliberate. With the ERJ program firmly in place and the family approach working as well, Embraer decided to embark on its next program without state financing.

E-Jet Series

In 1999 the company announced its intent to develop a new range of aircraft, called the E-Jet series. From the start a family approach was envisaged, resulting in the 170, 175, 190 and 195 models. Seating capacities range from 70 seats through 122 seats, putting Embraer squarely into the mainline aircraft market for trunk airlines.

This design, a more traditional aircraft with under wing engines, is now the new baseline from which Embraer will move forward to larger designs.

Embraer offers E-jets (image Wikipedia) with capacities from 75 seats to over 120 seats. This means the E170/190 family brackets a significant portion of the 100-seater market, and Embraer offers more options in the bracket than any other manufacturer.



By offering a family Embraer ensures that operators benefit from commonality in pilot training and flight decks. Airbus has demonstrated the attraction of a common flightdeck – a pilot trained on any of its modern fly-by-wire aircraft can quickly transition to other models with limited

training. By following this example, and the lead of Airbus, Embraer is able to offer a cost effective solution that airlines find attractive.

The following table illustrates the market acceptance of the E-jet family among airlines and lessors. The E190 is by far the most popular version ordered, accounting for 50% of orders to date, followed by the E170. As the last column shows, the order concentration is quite specific. The top seven customers account for just over 50% of all orders. JetBlue is the largest customer for the aircraft, and Embraer is no doubt pleased that JetBlue's founder David Neeleman has focused on the same aircraft for his next airline, Brazil's Azul.

Given the competitive nature of this market segment, Embraer cannot rest on its laurels long. New competitors, including the MRJ and CSeries promise superior operating economics that will render the recently introduced E-Jets economically disadvantaged. Embraer is evaluating its product portfolio, and perhaps will offer improvements to better compete with the P&W geared fan. While not revealing any future plans, Embraer indicated to us that it plans to maintain its leadership in the 100 seats segment.

Embraer feels comfortable with its position today. It does not fear the ARJ-21 since it offers nothing new in terms of technology. The Chinese are new at commercial aircraft development and lack any serious product support, certainly outside China. In terms of Russia and the Superjet 100, they too, are new at this game. Embraer does not believe the SAM146 engine will offer more than a 1.7% better fuel burn than the CF-34. With respect to the Japanese, they again see a lack of experience, and cast doubt on their ability to deliver promised performance on a timely basis.

The real threat comes from Bombardier. A proven competitor, Bombardier is taken seriously. However, Embraer points out that the CSeries wing is optimized for the larger -300. That means the C-100 has a larger wing than needed, and as a result the C-100 will weigh ~5,000kg more than its E-195. Even with the geared fan, Embraer expects to see the C-100 only offer a 2% fuel burn advantage over the E-195. Given that the C-100 is a new design with a program settling-in period, Embraer believes it has some time before it needs to react to the new competition.

E-Jet Family Orders and Deliveries

	170		175		190		195		E-Family			Order Concentration
	Orders	Del.	Orders	Del.	Orders	Del.	Orders	Del.	Orders	Share	Del.	
JetBlue					105	45			105	11.9%	45	11.9%
Republic	48	48	54	54					102	11.6%	102	23.5%
US Airways	28	28			42	25			70	8.0%	53	31.5%
Air Canada			15	15	45	45			60	6.8%	60	38.3%
Hainan					50	12			50	5.7%	12	44.0%
GECAS	9	9	5	5	24	23	7	7	45	5.1%	44	49.1%
Azul					5	3	31	5	36	4.1%	8	53.2%
Northwest			36	36					36	4.1%	36	
Lufthansa					16	0	14	7	30	3.4%	7	
Saudia	15	15			10	1			25	2.8%	16	
Virgin Blue	6	6			18	13			24	2.7%	19	
Finnair	10	10			13	10			23	2.6%	20	
LOT	6	6	16	4					22	2.5%	10	
BRA							20	0	20	2.3%	0	
Regional	9	5			11	8			20	2.3%	13	
KLM					17	5			17	1.9%	5	
Copa					15	15			15	1.7%	15	
Flybe							14	14	14	1.6%	14	
Aeromexico					12	2			12	1.4%	2	
EgyptAir	12	12							12	1.4%	12	
Globalia							12	5	12	1.4%	5	
BA City	6	0			5	0			11	1.3%	0	
TACA					11	6			11	1.3%	6	
Apli							10	0	10	1.1%	0	
JAL	10	3							10	1.1%	3	
Jetscape	1	1			9	1			10	1.1%	2	
Virgin Nigeria	7	0			3	1			10	1.1%	1	
M1					8	3			8	0.9%	3	
ETA	7	0							7	0.8%	0	
Alitalia	6	6							6	0.7%	6	
Aero Republic					5	5			5	0.6%	5	
KunPeng					5	5			5	0.6%	5	
Niki					5	2			5	0.6%	2	
TRIP			5	3					5	0.6%	3	
ECC	4	4							4	0.5%	4	
Royal Jordanian			2	2			2	2	4	0.5%	4	
Suzuyo	2	2	1	0					3	0.3%	2	
TAME					3	3			3	0.3%	3	
Air Caraibes			1	1	1	1			2	0.2%	2	
LAM					2	0			2	0.2%	0	
SAA	2	0							2	0.2%	0	
TAME	2	2							2	0.2%	2	
Others	3	3			2	0			5	0.6%	3	
Total	193	160	135	120	442	234	110	40	880	100%	554	
Share	22%	29%	15%	22%	50%	42%	13%	7%				

Canada

BOMBARDIER

Bombardier is a Canadian conglomerate with activities including personal recreational vehicles, rail cars, and aerospace, producing both business jets and regional aircraft. Bombardier acquired Canadair, which produced the Challenger business jet and Lear, which produced the Learjet business aircraft, the design eventually emerging as its Canadair Regional Jet. The company also acquired DeHavilland Canada, which manufactures a turboprop regional aircraft, and currently produces the Dash-8 in several models. With both turboprops and regional jets, Bombardier is well positioned in the regional airliner marketplace.

CRJ

Bombardier entered the regional jet market with the Canadair Regional Jet, based on the popular Challenger business jet fuselage and design configuration, in the late 1980s, with initial deliveries of the 50-seat CRJ-100 in 1992. Since the initial introduction, Bombardier has stretched the CRJ with 3 additional models, the 70-seat -700 series, the 90-seat -900 series, and the 100 seat -1000 variant, which will enter service in 2010.

The CRJ combines jet speed and comfort with economics comparable to turboprops and found strong market success in the low fuel cost environment from 1990 to early in this decade. However, with rising fuel prices and continued pressure on yields, 50 seat jets quickly lost their economic advantage and remain successful only in higher yield business markets. Fortunately, Bombardier was able to stretch the CRJ and maintain a favorable position in the regional jet market with smaller CRJ operators, who found the benefits of commonality with smaller versions to outweigh a transition to the more capable Embraer E-Jets of similar capacity.

Bombardier claims its CRJ-1000 offers up to a 15% reduction in operating cost against its closest competitor, making this aircraft the “optimized solution in the regional airline industry for medium-haul route applications and as the replacement of narrow body aircraft in thin markets”.

But in our view, the CRJ, despite super-stretched models, is rapidly approaching obsolescence. Bombardier has wisely looked up-market recognizing that the operating economics of regional aircraft have become difficult in low yield environments and has introduced the 110-130 seat CSeries as its next offering.

CSeries



The Bombardier CSeries (image FlightGlobal) is a new aircraft design scheduled for service introduction in 2013. Sized in the 100-149 seat range, the CSeries will utilize the new Pratt & Whitney PW1000G Geared Turbofan engine and is projected to provide a ~16% improvement in fuel burn over currently produced models. The CSeries will compete with the larger 190 and 195 model E-Jets from Embraer, the Boeing 737-600/700 and the Airbus A318/A319.

As the launch customer for the new Pratt & Whitney geared turbofan engines, Bombardier could gain an advantage by being the first to adopt the next generation of engine technology. The CSeries will be initially produced in two models. The CS100 will accommodate 100 passengers in two-class configuration or up to 125 in high density economy. The CS300 will similarly accommodate between 120 and 145 passengers. The aircraft will be configured in a 2 by 2 seating configuration in business class and 2 by 3 in economy class. The middle seat in economy will have a one inch wider seat than the window or aisle seats. We question, from an inventory-cost perspective, the wisdom of having a row of seats 1 inch wider than the others even if we as passengers will enjoy the extra room. We also question the design of a 2x3 seating for long-term residual value. One only need look at the freighter market potential of the 2x3 McDonnell Douglas DC-9 and MD-80/90 series vs. the 3x3 of the Boeing and Airbus single-aisle aircraft to draw conclusions on this subject.

The CSeries will utilize advanced materials, constructed with 46% advanced lightweight composite and 24% aluminum-lithium to produce significant weight savings. The aircraft will utilize fly by wire technology with side stick controllers, an advanced flight deck utilizing advanced systems integration, electronic brakes, and will be optimized for short runway performance. With new technology engines, Bombardier expects best in class performance for the CSeries in terms of noise and emissions as well as fuel economy, making the aircraft more environmentally responsible than competing models.

Configuration

The CS100 will have an overall length of 114 feet 6 inches, and a wingspan of 115 feet 1 inch. The larger CS300 will have an overall length of 124 feet 10 inches and a wingspan of 115 feet 1 inch.



Source: Bombardier

Extended range versions of the aircraft will be offered, with additional fuel capacity to enable 2,950 nautical mile range for full transcontinental operations. Standard range for the aircraft will be 1,800 nautical miles.

The CSeries was to be the first narrow-body aircraft to offer pivoting overhead bins, similar to those found on wide body aircraft to offer more overhead bin capacity. Boeing trumped this with the April 28, 2009 announcement that it will offer the 787-inspired Sky Interior on the 737 from 2011, with pivot-bins.

Market and Competitive Position

The CSeries is scheduled to enter service with launch customer Lufthansa by 2014, and the development program remains on target. Lufthansa will utilize the 30 CSeries aircraft on order for its subsidiary Swiss International Airlines, replacing less efficient four-engine Avro RJs. In addition to the 30 firm orders from Lufthansa (which also has 30 options), an additional order for 20 aircraft has been placed by Lease Corporation International based in Ireland.

Bombardier, through the success of the Canadair Regional Jet and DeHavilland Dash-8 models, has an established service and support infrastructure in place, and has demonstrated that it can meet airline requirements for maintaining dispatch reliability in global markets. This provides a significant advantage over competitors from Russia, China and Japan, which currently lack the any similar capabilities.

A key issue for operators is whether the fixed investment in a unique aircraft for the 100-135 seat range makes economic sense given the commonality of the larger 737 and A320 family models that cover a

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wider seat range with the same type ratings, crew training programs, engines, and maintenance procedures.

Competition

Bombardier has selected an interesting niche for the CSeries, which competes with the largest models of Embraer E-Jets and with the smallest members of the A320 and 737 families. While the stretch version of the Mitsubishi Regional Jets and Sukhoi Superjet will be a direct competitor for the CS100, Bombardier has positioned this aircraft as a small trunkliner rather than a larger version of a regional jet.

Outlook

Bombardier projects a market for 6,300 aircraft in the 100-149 seat class over the next 20 years, and believes it can capture nearly half of that market, or 3,100 aircraft. That would translate to production of more than 150 aircraft annually during that period. This is a very aggressive goal and while we believe the aircraft will be successful, we do not believe it will capture a 50% market share. We project a market for about 1,500 CSeries over the life of the program if Boeing and Airbus offer a 130-seat model and 2,000 aircraft if Boeing and Airbus offer only 150- to 200-seat models in their next generation of narrow-body aircraft.

With the delay of new technology, narrow-body aircraft from Boeing and Airbus until the 2020 decade, Bombardier will have a 6 to 7 year market advantage on its larger competitors (absent an A320/737 RE program), with the ability to offer a new technology aircraft with significantly better fuel efficiency for a small trunk-line aircraft. That combination should be able to find a niche.

China

China has long entertained the prospect of developing its own viable aerospace industry. Although there have been a few indigenous commercial airliners, none has been successful by any definition of the word.

With the current development of the 70-100 seat AVIC ARJ21, now in test flights, and the unveiling of the Comac C919 in the 150-200 seat market, coupled with extensive use of Western components and engines, China is finally poised to make airliners that must be taken seriously.

Many industry participants and analysts are split on the likelihood of China becoming a potent competitor in civil aviation. We fall in with those who believe China will become a significant competitor, as its domestic market is poised to overtake the US as the world's largest market for aviation in the future.

To dismiss China's potential is to fail to understand China's psyche. We don't pretend to be psychiatrists but we are students of history and we have experience doing business in China. China's leaders are determined to make the country a world power in all respects and they are well on their way to doing so. Consider:

- Since Nixon went to China, in 1972, then a closed society, and only 37 years ago, China has by any measure become an economic Super Power. It holds more US debt than any other single nation. Recently its leaders called for abandonment of the US dollar as the world's currency standard. The call has yet to gain traction but it wasn't dismissed as ridiculous as it would have been only a few years earlier. This speaks as much to China's rise as it does to the US's fall. Despite continuing to have one of the world's worst records on human rights, nobody seriously even discusses the prospect of economic sanctions, so powerful is China's position now in the world economy.
- China is rapidly developing a Blue Water Navy and within a few years will be able to challenge US supremacy on the high seas in targeted areas. China has sent men into space and is currently planning a Mars probe.
- China's auto industry is more aggressive about alternative energy than Detroit or Western Europe; only Japan seems as aggressive in this arena.
- China is turning out more engineers than the US.
- China is a major threat to cyber security, with its universities offering curriculum on cyber exploitation.

China's national mind set is to plan and play for the long-term. The culture is very patient to get results. Macau was returned to Chinese rule by Portugal after *450 years* and Hong Kong was returned to Chinese

rule by Britain after 99 years. Chinese officials are still waiting for the day when the “renegade” province, Taiwan, returns to the fold after 40 years. Patience is a virtue and the Chinese have a lot of it.

Development of a viable commercial aerospace industry has significant barriers to entry, as noted analyst Richard Aboulafia of the Teal Group has regularly observed: there are high costs, technology barriers, and a global product support infrastructure is required. It’s tough but not impossible. Embraer proved it, and, of course, so did Airbus. Airbus’ first airplane, the twin-engine wide-body A300B2 series, entered service in 1974 with Air France. In only 20 years, Airbus achieved parity with Boeing for the first time, and while there have been ups and downs since then, the two manufacturers remain roughly equal in today’s market.

Observers point out that Airbus evolved from a long history of European aerospace companies and that China doesn’t have such a history. We partially agree on the latter. China’s history may not be as long as that in Europe, but it has been producing major components for Boeing, and more recently, Airbus for many years, and gained knowledge from the McDonnell Douglas MD-80/90 production program that is being used on the ARJ21.

Just as Airbus began with sales from a state-controlled company to a state-controlled airline, so will China, with its ARJ21 and Comac C919. We don’t expect either airplane, which are essentially prototypes, to sell particularly well outside China. The ARJ21 is too heavy to economically compete against Western designs in the 70 to 100-seat space, but we consider this entirely beside the point. The ARJ21 will serve as a proof-of-concept airliner from which better airplanes will flow.

The Comac C919, at least on paper, is a much more viable project than the ARJ21. Whether concept will translate into a good airplane remains to be seen. For the moment, we also view the C919 as the first viable step in the evolution of China’s aerospace industry.

It must be remembered that the A300B series were just “OK” airplanes. They were under-powered and the Airbus support system had a lot of kinks to work out. The A300-600R was a much-improved version on the B4, but it was still inferior to the Boeing 767-300ER, and the A310 derivative lagged the 767-200 series. Subsequent Airbus airplanes (the perpetual debate over the A340 aside) have proved to be technically and economically successful. We envision a similar progression for China’s airplanes subsequent to the ARJ21 and the C919.

We view the ARJ21’s commercial prospects limited for reasons discussed below. The order by GECAS for 25 ARJ21s is, in our view, little more than a quid pro quo for GE engines powering the ARJ21 and the price of doing business in the country.

This raises another element of the Chinese psyche. China’s political and business philosophy is about “benefit.” “Benefit” to Chinese leaders is about local jobs and local technology. This explains long-standing policy by the Big Four airframe OEMs to outsource to China and the more recent dramatic increase to do so, including the establishment of the Airbus and Embraer production lines in China. Clearly having China-based production should provide “special access” to its burgeoning market.

ARJ21



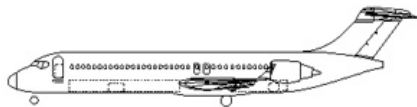
The ARJ21 (image Jaunted.com) is the first Chinese project that makes broad use of Western components and begins to use Western-style production techniques. In a funny but dismissive comment about the ARJ21, consultant Michael Boyd of The Boyd Group remarked, “They have invented the DC-9-10.”

Indeed, for obvious reasons, the ARJ21 looks like America’s first twin engine jet. The jigs used were left over from the McDonnell Douglas MD-90 Shanghai assembly plant. The ARJ21 is about the size of the original Douglas DC-9-10/30. The ARJ21 is among the heaviest aircraft of the 70-100 seats category, and therefore will be challenged in its operating economics. The 70- to 90-seat ARJ21 MTOW is 82,826 lbs. The 90-seat DC-9-10 had a MTOW of 90,700 lbs. The 80-seat Embraer E-170 Standard MTOW is 79,178 lbs.

ARJ-700系列
70-80座級



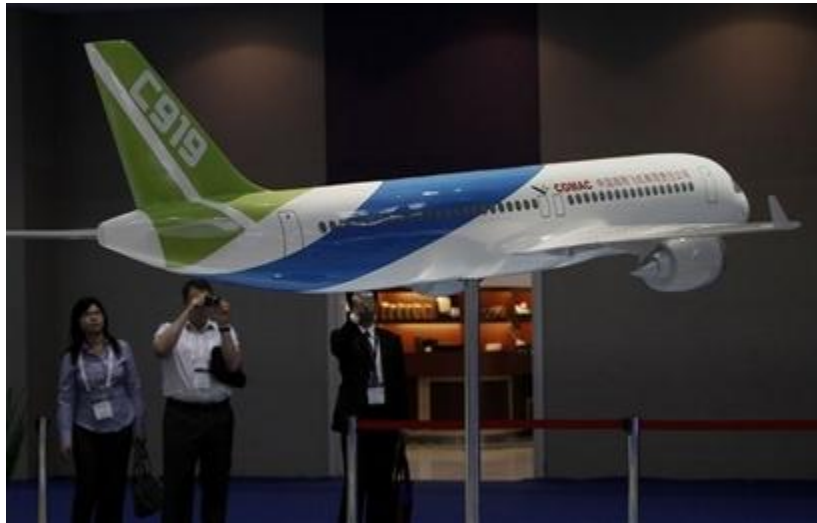
ARJ-900系列
90-100座級



The ARJ21 is the first product of the AVIC I Commercial Aircraft Company, a consortium comprised of Chengdu Aircraft Industry Group, Shanghai Aircraft Co., Shenyang Aircraft Corp. and Xian Aircraft Co. A long list of Western suppliers includes GE (engines, CF-34), Honeywell (fly-by-wire avionics) Goodrich (interiors) Rockwell Collins, Hamilton Sundstrand and several from Europe. There are nearly 250 orders, including two from Lao Airlines (Laos) as well as the aforementioned 25 from leasing giant GECAS.

The ARJ21-700 seats 78 in two class configuration and 90 in a single class layout, the size of the original DC-9-10. The ARJ21-900 seats 98 and 105 respectively, the size of the DC-9-30 and Boeing 717 (nee MD-95). The range of the -700 is 1,200nm for the standard version and 2,000nm for the ER. The larger -900 is advertised with the same range for the standard version, but 1,800nm for the ER. Runway take-off length for the -700 is 5,600 ft and 6,200 ft; and 5,700 ft and 6,400 ft for the -900. The aircraft will have a service ceiling is 39,000 ft.

COMAC C919



Another emerging Chinese airliner is the COMAC C919 (image People's Daily), a 150-200 seat jetliner that is, to use an old vernacular, the Chinese copy of the Airbus A320. It looks like the A320 and it is dimensionally virtually identical. This is not surprising since Airbus located an A320 assembly plant in Tianjin.

The C919 will be offered in three variants, the standard model seating 156 in dual class configurations, with smaller 130- and larger 190-seat variants – quite similar in size to the A319 and A321, respectively.

China is seeking western engines for the aircraft, and has been in negotiations with CFM International, Pratt & Whitney and International Aero Engines regarding new technology engines. With choices from LEAP-X, PW1000G geared turbofan, and second generation IAE V2500 engines, the C919 is projected to have a 16% advantage in fuel economy over today's Boeing 737 and Airbus A320 offerings. An engine selection is expected by year-end. We predict CFM and the LEAP-X will be the choice. Not only is GE already supplying the engine for the ARJ21, it was announced in late September that China's AVIC (a forerunner of COMAC), France's Safran and GE entered into agreements to establish new facilities in China and to lend expertise to establish a production line for indigenously design and produce engines. A new joint venture will also design engine nacelles and components for the C919. We would be quite surprised if the C919 were powered by PW, given the significant technology transfer activity by GE.

An eight-year development program has been planned, with first flight in 2014 and entry into service in 2016. COMAC has sought western technology for the aircraft, and initial contracts include Goodrich (via a joint venture) for landing gear and Honeywell for flight controls. We believe both dates to be ambitious for a first-time project. The original dates suggested by the Chinese provided for a 2017 first flight and 2020 EIS. We think these are likely too long and look for something in between.

While we do not expect the C919 to gain significant market penetration outside of China, the aircraft will sell well domestically and perhaps in China's sphere of influence in Africa. As a replacement for narrow-bodies from Boeing and Airbus domestically, the C919 has the potential for a significant production run. The 2009 market forecast from Airbus projects 4,238 narrow-body aircraft between 2009-2028 for the Asia-Pacific market, of which the vast majority will be for China. Boeing, in its 2009 market outlook, projects demand for 5,000 narrow-body aircraft for the Asia-Pacific market over the same time period, with 2,670 trunk aircraft in China. If the C919 enters service in 2016, it will compete for a market of more than 2,670 aircraft for China between 2016 and 2028, and could capture 30%-50% of that demand, or about 800-1,335 aircraft over 12 years. That is not insignificant to today's incumbents, whose market potential will shrink accordingly.



Specifications for the C919 are sketchy at this time. The fuselage width and height are 3.96 and 4.166 meters respectively, marginally larger than the A320.

	C919	A320
Length		37.57m
Height		11.76m
Fuselage Diameter	3.96m	3.95m
Cabin width		3.70m
Cabin length		27.51m
Wingspan	33.6m	34.10m
	35.4m winglets	
Payload	20.4 metric tonnes	16.6 metric tonnes (A320) 21.2 metric tonnes (A321)
Cruise Speed	0.785 Mach	0.82 Mach
Max Altitude	12,100 m	
Range	2,200nm	3,000nm
	ER: 3,000nm	

Although many press articles describe the C919 as “far more advanced than its Western rivals,” based on the limited information available, this appears true only to the extent that the engines are expected to be the next generation. Avionics, components, etc., are being sourced from traditional Western aerospace companies. Nothing suggests that these components are ground-breaking technology. There is nothing we’ve seen about the fuselage design that suggests there is anything innovative, either in design or construction.

China’s air traffic system is notoriously inefficient and still controlled by the military. A major component of the 40% Solution sought by Airbus and Boeing for their new airplanes are an extreme makeover of the European and US ATCs, and by implication, the Asian ATC as well. Boeing is offering Required Navigation Performance equipment as standard in the 737 from 2011. We’ve seen nothing to suggest this is a possibility in the C919, which is not to say it isn’t, but given the antiquated nature of the Chinese ATC, we’d be surprised if RNP is going to be a feature. Southwest and Alaska airlines in the US are

finding it more costly and challenging to implement RNP on their airplane than expected and we doubt China is going to be advanced in this arena.

Thus, other than the new generation engines, we don't see what's so advanced about the C919, contrary to the hype. If Airbus and Boeing proceed with A320RE and 737RE programs, the operating economics should at least match the C919, depending on the airframe drag of the new airplane. The C919's advantage then comes down to price and the directives by the Chinese governments for the domestic airlines to buy the airplane whether they want it or not.

Despite the obvious conclusion that we can control our enthusiasm for the C919, we reiterate that we regard this as but a proof-of-concept airplane that will lead to better ones down the road. At this writing, no orders have been placed for the C919. A news report out of Beijing says that COMAC hopes for 90 orders in the first half of 2010.

There are conflicting reports of how much money the Chinese government will put into COMAC for the C919. Aviation Week reports that COMAC says the budget is \$4.4 billion, but reports that state media says China will spend a whopping \$29.3 billion. We can't help but note that the foundation for a forthcoming WTO case regarding state support for aviation is being built.

Japan

Mitsubishi Regional Jet

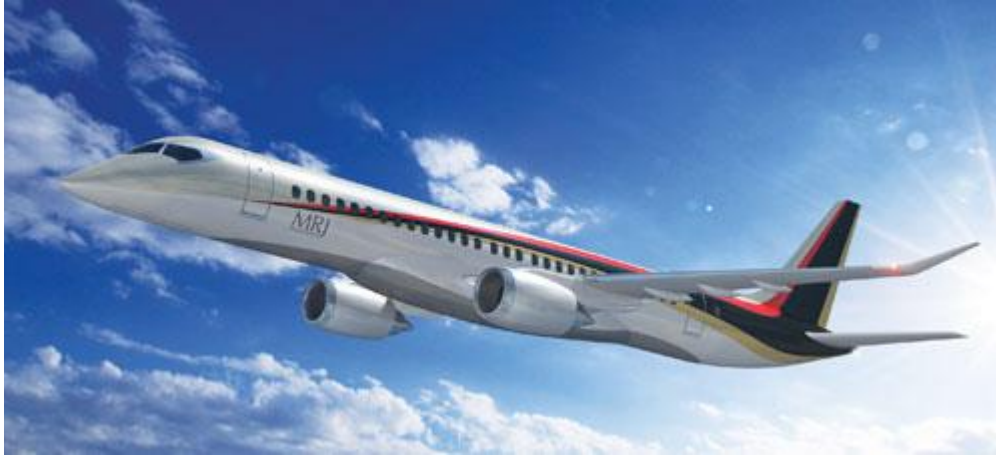


Photo Credit: Mitsubishi

Japan produced some of the most technologically advanced airplanes in the 1930s and early 1940s, with the famed Mitsubishi Zero fighter plane initially striking fear into American pilots at the beginning over World War II. Although Japan's planes were soon eclipsed by American technology, the Japanese air and naval forces remained a formidable force.



Post-war Allied rules prohibited a meaningful Japanese aerospace industry. Japan attempted to develop a commercial aerospace program with the YS-11, a 60-passenger turbo-prop meant to compete with the venerable but smaller Fokker F-27 and the jet-prop conversions of the reliable Convair 340/440 series. (Photo Credit: Keymountain.nl)

The YS-11 was a modest success, with nearly 200 built and some foreign sales. Japan did not pursue a follow-on model nor attempt to develop a commercial jet, however.

Japan's so-called Heavy Industries (Mitsubishi, Fuji, and Kawasaki) desired a role in jet airliners and had a false start with Boeing in the development of the 757. Japan hoped to become a risk-sharing partner in the 757 but in the end simply became a supplier, with Boeing retaining control over design and engineering. So it remained until the development of the Boeing 787, when Japan finally achieved its ambition of participating in design and engineering. The Japanese Heavy Industries design and build the

wings, wing-box and some of the fuselage for the 787. The Japanese government provided initially \$1.2 billion to the “Heavies” for their roles in the 787 program.

With the start of the 787 program in 2004, Japan lost little time in proceeding with a plan to develop its own commercial aerospace industry, announcing plans in 2007 to build a 70-90 seat regional airliner, the MRJ. (Yet another example of technology transfer.) All Nippon Airways placed an order for 15 and an option for 10 of the 90-seat version the following year. Mitsubishi announced that it would take advantage of its experience on the 787 program and use this technology for the wings and wing box on the MRJ.

In fact, Mitsubishi began investigating the prospect of getting into the RJ years before that, at a time when 30-seat RJs were still popular. Through a consulting firm, Mitsubishi surveyed US regional airlines about their wants and desires for a 30-seat jet that would have been in competition with the Embraer EMB-135.

The market has clearly passed by the 30- and 50-seat RJ. Mitsubishi announced the offering of its 70-90 seat MRJ at a time when fuel prices spiked to more than \$4 per gallon and regional airlines were grounding current generation 30- to 70-seat RJs as uneconomic. Horizon Air in the US announced plans to phase out all 70-seat Bombardier CRJ-700 jets in favor of the 70-seat Bombardier Q400 turbo-prop, in part to standardize on one fleet type and in part because the turbo-prop offered better economics.

Trans States Airlines of the US announced on October 2, 2009, an order for 50 MRJs and options for 50 more. The sub-type was not announced but Mitsubishi said that the airline is considering the two existing versions and the potential 100-seat+ model. This gives a major boost to the program, both from a quantity perspective but also from a significant US regional airline. It remains to be seen how many, if any, 70-seat models are selected by Trans States.

The MRJ will have Pratt & Whitney’s P1000G Geared Turbo Fan, which promises ~16% better fuel burn than today’s engines. EIS for the MRJ-70 is slated for 2014 and the following year for the MRJ-90. Whether the P1000G will prove capable of making the difference between profit and loss for the 70-seat MRJ when fuel prices someday return to \$4 per gallon remains to be seen.

We have concern that Mitsubishi may miss the market with the MRJ. We believe that the 70-seat RJ has seen its day. Mitsubishi would have been better to start with the 90-seat version and grow from here. The recent announcement of a potential growth version over 100 seats indicates that the company has also identified the future “sweet spot” in the market.

The company, in a notable announcement, said it is abandoning plans to use 787-derived composite technology to build the wing-box and wings, reverting to aluminum. The ever-polite Japanese firm said it is easier to use aluminum to grow airplanes the smaller they are, but observers noted that it has been Mitsubishi’s responsibility on the 787 wings and wing box, and that Boeing has had not one, but two, major problems with the wing box structural design. This raises the question whether the real reason Mitsubishi is reverting to metal is from lessons learned on the 787.

As with all the emerging airliners, the MRJ has broad-based support from Western aerospace companies.

Spirit AeroSystems will design and build the pylon. The contract marks Spirit's entry into the regional jet market. Parker Aerospace supplies hydraulic systems, Hamilton Sundstrand supplies the electric power, air management, inert gas system, high-lift actuation and fire and overheat protection systems and the auxiliary power unit; Rockwell Collins and Japan's Nabtesco Corp. provide the flight control system; and Sumitomo Precision Product Co. provides the landing gear

Development cost is pegged at ¥150 billion (\$1.5 billion), which would be the lowest (and probably highly unrealistic) R&D of any new airliner. One third of the funding is being provided by the Japanese Ministry of Economy in the form of refundable launch aid.

Mitsubishi projects demand for up to 1,000 aircraft, around 20% of the 5,000 sales forecast in the 70-90-seat bracket over next 20 years.

	MRJ 70STD	MRJ 90STD	MRJ 90ER	MRJ 90LR
Passengers	70-80		86-96	
Length	32.8m (107.6 ft)		35.8m (117.5 ft)	
Wing span	30.9m (101.4 ft)		30.9m (101.4 ft)	
Tail height	10m (32.8 ft)		10m (32.8 ft)	
Max takeoff weight	36,850kg (81,200lb)	39,600 kg (87,300lb)	41,450 kg (91,400lb)	42,800 kg (94,400lb)
Empty weight	21,700kg (47,800 lb)		22,600 kg (49,800 lb)	
Max range	1,480km (800nmi)	1,610 km (870nmi)	2,590 km (1,400nmi)	3,280 km (1,770nmi)
Typical cruise speed	0.78 (515 mph, 828 km/h) max. 0.82 (563 mph, 906 km/h)			
Takeoff field length (MTOW,SL,ISA)	1,390m (4,560 ft)	1,460 m (4,790 ft)	1,590 m (5,220 ft)	1,690 m (5,540 ft)
Landing field length	1,390m (4,560 ft)		1,450 m (5,760 ft)	
Powerplants	P&WPW1217G			
Engine thrust	66.7kN (15,000lb)		75.6kN (17,000lbf)	

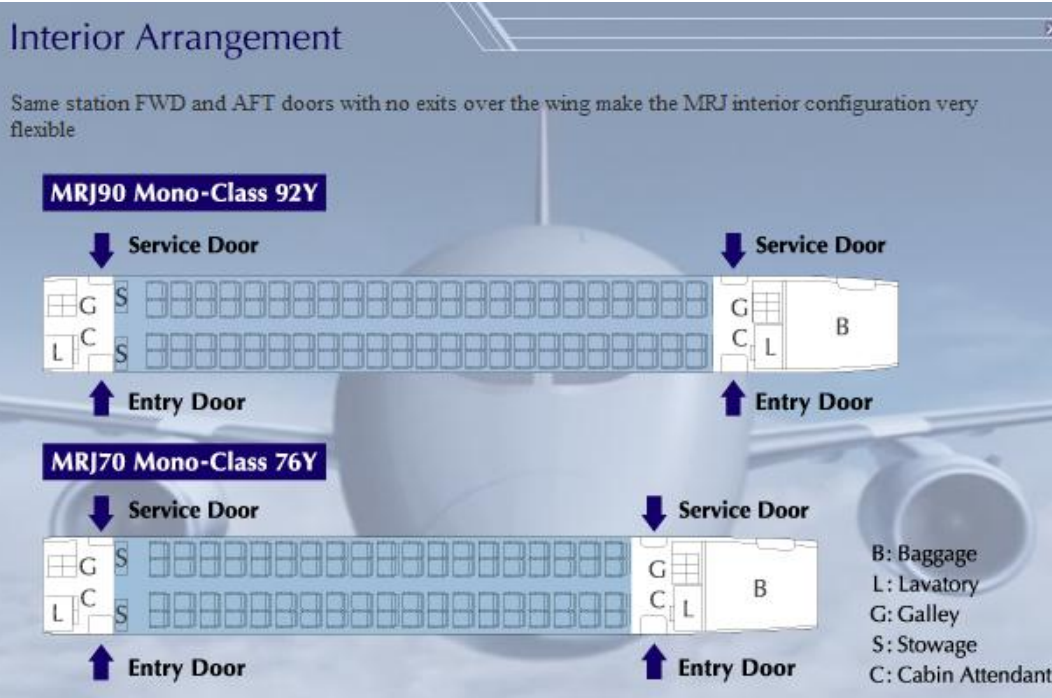


Image: Mitsubishi

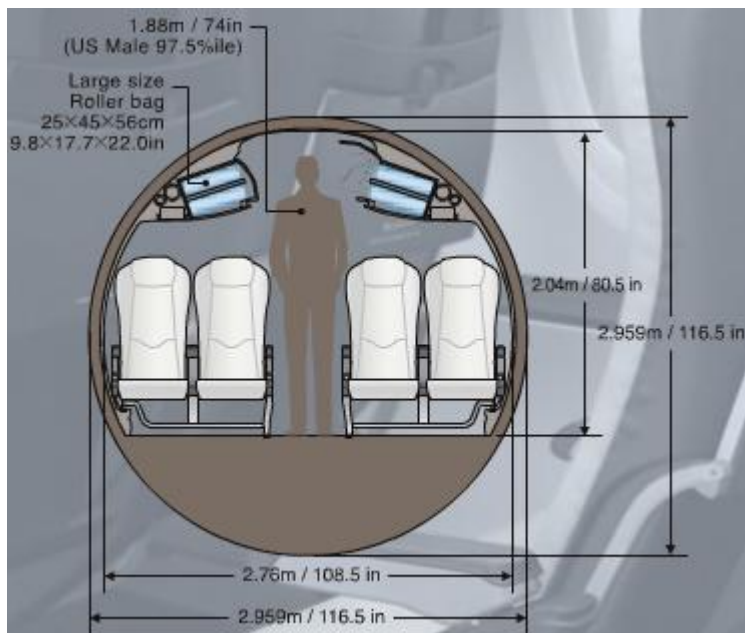


Image: Mitsubishi

Kawasaki Heavy Industries YPX

Kawasaki, another industrial partner on the Boeing 787 program, announced its intention to develop a 100- to 150-seat jetliner. This will compete with the Boeing 737-700/800, Airbus A319/A320 and Bombardier CSeries. EIS is estimated for 2018-19. The program was revealed during the Farnborough Air Show in 2008 and very little information has been forthcoming since.



Photo Credit: Flightblogger

The airplane was announced under the Kawasaki name but is being developed by Japan Aircraft Development Corp. The aircraft is intended to be lighter than the Bombardier's CSeries in the same market segment.

Range is initially identified as 2,300nm to 3,200nm. The aircraft would have 2x3 seating and an MTOW of 123,900 lbs, slightly lighter than the CSeries, while carrying a few more passengers and flying a bit farther.

As the moment, we view this program as more conceptual than reality.

Russia

The Russian aerospace industry was consolidated into a single corporation, United Aircraft Company (Объединенная Авиастроительная Корпорация) in 2006 by Russian President Vladimir Putin. That process gathered the best elements of the aerospace industry - including such brand names as Mikoyan-Gurevich (MiG) and Sukhoi in defense and Antonov, Ilyushin, Tupolev, and Yakovlev in the commercial sector, with Beriev, and several key manufacturing facilities and design bureaus. UAC is the largest conglomerate in Russia, and has a small cross-shareholding with EADS, over 100,000 employees, and is more than 90% government owned.

The company is currently active in seven civilian aircraft programs: the Antonov An-148, Ilyushin IL-114, Ilyushin IL-96, Tupolev Tu-204, Tupolev Tu-334, Sukhoi Superjet 100 and the MS-21.

Several of these programs are quite old and commercially unsuccessful in global markets, including the Tupolev Tu-204 and Ilyushin IL-96. The IL-114 turboprop program is aimed at the domestic Russian market, and the Tu-334 program is being dropped in favor of the utilitarian domestic focused An-148 and the more internationally oriented Sukhoi Superjet program. The MS-21, a Tu-154 sized replacement with western engines and new technology, will also compete internationally with the A320 and 737-NG families utilizing advanced technology engines.

Commercial freighter programs include the supersized Antonov An-124, Ilyushin IL-76, Ilyushin IL-96-400T, Ilyushin IL-112, Ilyushin IL-114T, Irkut Multirole Transport Aircraft, and Tupolev 204C. Most are aimed at the Russian market, with the exception of the exceptionally large An-124, for which production may re-start given demand for outsized freight. The An-124 has proven to be a commercially successful program and the aircraft is even chartered by the Pentagon to deliver outsize cargo to Afghanistan.

Two programs from Russia are relevant to the global marketplace, the Sukhoi Superjet 100 and the UAC MS-21. The older programs, including the IL-76, IL-96, IL-112, IL-114 and Tu-204 have been unsuccessful outside the CIS and are not relevant in global markets.

Sukhoi Superjet 100



Image: Sukhoi

The Sukhoi Superjet is a regional airliner that will compete with the Embraer's E-Jets, and future competition from the Mitsubishi RJ and Bombardier CSeries. The Superjet is a joint venture aircraft program with 75% ownership by Sukhoi Commercial Aircraft Company and 25% by Italy's Finmeccanica, through Alenia Aeronautica. This program has more western content than any previous Russian aircraft program, including SNECMA as a risk sharing partner with its PowerJet SaM146 engine, consulting services from Boeing, and Honeywell, Parker, Hamilton Sundstrand, Thales Group, Liebherr, Messier Dowty, Intertechnique, B/E Aerospace, Goodrich and other western supplier supplying aircraft subsystems.

As a result, the Superjet 100 is the first Russian aircraft designed specifically to be marketed on a global scale, utilizing well-known international suppliers rather than local Russian companies. Alenia will provide service and support outside of Russia from facilities in Italy and its global network, while UAC will provide service and support within Russia. To date, the program has had limited success in the western market, with orders from ItAli Airlines (Italy), AMA Group (Switzerland) for executive aircraft, Kartika Airlines (Indonesia), Malév Hungarian Airlines (Hungary) and Gadair European Airlines (Spain) placing firm orders. Aeroflot, Finance Leasing Company, Avia Leasing, Dalavia and Gazprom have ordered aircraft in Russia and Armavia in Armenia. The program currently has 149 firm orders and 84

51

options.

While the Sukhoi Superjet 100 has not yet caught the fancy of western operators, it should find a strong regional jet replacement market with Aeroflot and other domestic Russian operators of Tu-134 and Yak-42 aircraft on domestic routes.

The Superjet 100 is noteworthy for several reasons. First, while a Russian aircraft, it is built with mostly Western systems and content and is an acceptable aircraft in the international market. Second, however, it is a relatively unknown manufacturer competing with Embraer and Bombardier, who have well-established service and support networks worldwide, leaving the Superjet at a disadvantage. Nonetheless, this is the best commercial aircraft yet from Russia, and will be competitive with western aircraft at an attractive price point.

Originally scheduled to be in service in 2008, the program has been delayed, with first deliveries now projected in late 2009. The aircraft is currently completing its test flight program for Russian AP-25, JAR-25 and FAR-25 certifications, and meets ICAO Chapter 4 and FAR 36 Section 4 noise standards. The aircraft is built at the Komsomolsk-on-Amur Aircraft Production Association facilities in Russia.

The aircraft is powered by the Powerjet SaM146 engine (Двигатель СаМ146) produced by PowerJet, a joint venture between Snecma of France and NPO Saturn in Russia. Snecma produces the core engine, FADEC control system, transmissions, overall engine integration and flight testing. NPO Saturn is responsible for components in the low pressure section and engine installation on the aircraft.



Image: PowerJet

Technologically, the SaM146 is comparable with rivals from GE and Rolls Royce, and has been designed to offer lower operating costs than current alternatives. The engine was designed by Snecma (who

partners with GE on the popular CFM-56 series of engines from CFM International) to meet western airline requirements for fuel economy, dispatch reliability, maintenance and operating costs. The engine variants range from 14,000 to 17,500 lbs. for application on the two Superjet models, and are supported globally through the CFMI network.

The Superjet 100 will be offered in two variants, the 98 seat 100-95 model and the 78 seat 100-75 model. Sukhoi projects a 10-15% operating cost advantage over competing Embraer E-Jet and Bombardier CRJ jets with similar capacities. The list price of the aircraft is \$27.8 million US.

The aircraft has a 2 by 2 seating configuration with a modern interior designed by B/E Aerospace in the United States. Production rate for the aircraft is projected to build from 4 deliveries in 2009 to 70 aircraft per year by 2012.



Source: UAC

Customer Concentration

The Superjet 100 currently has 12 customers, all for the Superjet 100-95, the first model to enter service, with a concentration of 73.0% from the top 5 customers:

Superjet 100 Orders and Options				
Customer	Country	Orders	Options	Total
Aeroflot	Russia	30	15	45
Avia Leasing	Russia	24	16	40
Kartika Airlines	Indonesia	15	15	30
Malév Hungarian Airlines	Hungary	15	15	30
Superjet International	Russia/Italy	20	5	25
ItAli Airlines	Italy	10	10	20
Finance Leasing Company	Russia	10	0	10
Dalavia	Russia	6	4	10
Gazprom	Russia	10	0	10
AMA Group	Switzerland	5	0	5
Armavia	Armenia	2	2	4
Gadair European Airlines	Spain	2	2	4
Total		149	84	233
Concentration				73.0%

New engine technologies will define the next generation of 70-100 seat jets, and the Sukhoi Superjet 100 with its SaM146 engines will face competition from the PW1000 Geared Turbofan technology from Pratt & Whitney. With the new technology engines from Pratt & Whitney promising an additional 15% savings over existing technologies, the competing aircraft from Mitsubishi and Bombardier will enter the market with a slight advantage over the Superjet, which itself bests existing technologies. As a result, we expect the Sukhoi Superjet to be highly successful in the Russian market, but only modestly successful in the west, despite western systems and technology and the availability of service and support from both CFM international and Alenia. Nonetheless, the Superjet 100 will be a viable competitor to the Embraer E-Jets in emerging markets and could gain a foothold in China and India with strong marketing, which is the unknown element in the program.

Can a Russian-Italian joint venture be as successful as Embraer and Bombardier in marketing aircraft? We believe that the answer is not quite yet. Once the Superjet 100 proves that it is economical in service, with strong support, it may begin to gain a following. Unfortunately, by that time, established competitors will be delivering next generation technology aircraft in the same size class. Nonetheless,

the success of the Sukhoi Superjet could lead the way for additional success for future UAC programs, recognizing that an aircraft company is not built overnight.

UAC MS-21



Image: UAC

The MS-21 is an abbreviation for магистральный самолет 21 века, or 21st century airliner currently under development by United Aircraft Corporation. The design is driven by the Irkut division, which includes the Yakovlev design bureau, with participation from Tupolev, Sukhoi and Ilyushin design bureaus, incorporating the best of Russian design experience. The aircraft is aimed at the narrow-body market, specifically the replacement of the Tu-154 and Tu-204 in the Russian market and to compete with the A320 and 737NG in international markets.

This is, to some degree, a “bet the company” program for UAC that is aimed squarely at regaining leadership in manufacturing aircraft for the domestic market while extending the market for Russian aircraft internationally. UAC has established a goal of 50% of sales outside of Russia.

This new model is scheduled for market entry in 2016 to compete directly with the A320 and 737NG families while offering a 15% improvement in operating costs. Offered in 150-, 181- and 212-seat variants, it will compete directly with the comparable models in the Airbus and Boeing families.



The MS-21 is viewed as a “make or break” program for UAC and the Russian industry, which has set ambitious goals to break into global markets, following the Sukhoi Superjet. Unfortunately, UAC lacks the international support networks of Boeing and Airbus, which places it at a disadvantage in export markets.

The MS-21 is currently in the pre-design phase, with first flight expected in 2014 and first deliveries in 2016. The aircraft has targeted 15% lower operating costs than the current Airbus A320 and Boeing 737NG series, with three variants planned. The MS-21-200 will seat 150, the -300 will seat 181, and the -400 will seat 212. The aircraft will have transcontinental range of about 2,800 miles, and a cruising speed of Mach 0.8.

Extensive use of composite materials is expected in the design to maintain competitive economics with current and future western aircraft. UAC expects to include significant western participation in the MS-21, but through joint venture arrangements with Russian companies rather than the direct participation on the Sukhoi Superjet program. The company plans two power plant offerings, one for the domestic market and one based on western technologies. Pratt & Whitney, which has an existing joint venture with Perm Motors, is offering its PurePower PW1000G geared turbofan, which would provide a new technology power plant for the program. CFM International and Rolls Royce are also expecting to enter the competition, but with their existing relationship and the Perm PD-14 being offered for the domestic version, Pratt & Whitney are perceived to have a strategic advantage.

With the Pratt & Whitney engines, the MS-21 should have a 16% fuel burn and even higher operating cost advantage over current Airbus and Boeing narrow-bodies. However, with new narrow-body programs scheduled for introduction in 2020, the advantage if the MS-21 program meets its schedule would likely last only 4 years at best.

UAC’s goal is to bring the Russian industry up to world-class standards, and to recapture the domestic market that has been lost to Airbus and Boeing in new aircraft orders by 2015. They project sales of

1,000 MS-21 aircraft over the next 20 years, split evenly between the domestic and international markets. Should UAC achieve its sales goal, it will translate to 1,000 fewer sales for Airbus and Boeing.

Our view is that if Russia can develop the MS-21 on time and with its projected performance characteristics, it will be successful in the domestic market, and likely gain some market traction in developing countries. However, without of an extensive service and support network, UAC will be at a significant disadvantage to Airbus and Boeing in international markets. Nonetheless, if both the Sukhoi Superjet and MS-21 prove to be competitively cost-effective and reliable aircraft, UAC will be able to build on an international base to become a competitor in the global market over the longer term.

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About the Authors

Ernest S. Arvai heads The Arvai Group, an aviation focused strategy consultancy based in the United States, and has worked with aircraft manufacturers, engine manufacturers, component suppliers, airlines, leasing companies and financial institutions for more than 30 years.

Mr. Arvai holds an MSIA from the Tepper School at Carnegie-Mellon and a BSE from the University of Michigan. Prior to establishing his own firm, he was Vice President and Managing Director - Technology Management at Battelle Memorial Institute. During his career he also led the worldwide airline and aviation industry practice at Arthur D. Little and has worked in more than 50 countries on aviation issues. Additional information can be found at www.arvaigroup.com.

Scott Hamilton is Managing Director of Leeham LLC. Leeham was formed in 1999 by Mr. Hamilton, following the sale of the company he co-founded, co-owned and co-managed, Linkraven Ltd. Linkraven published the internationally-distributed Commercial Aviation Report and Commercial Aviation Value Report; and organized conferences in Asia, Europe and the Americas under the Commercial Aviation Events banner.

Mr. Hamilton joined the airline management ranks in 1979. In 1989, he and a partner formed Linkraven in Britain. During the 10 years Mr. Hamilton and his partner owned and operated Linkraven, Commercial Aviation Report, Value Report and the Events became internationally recognized for their breaking news reporting and high-quality conferences. The influential publications regularly beat larger and more established magazines and newspapers with news about the airline industry. Mr. Hamilton is frequently called by broadcast and print media to offer expert analysis about the issues of the day. He is a regular contributing writer for Commercial Aviation Online (the successor to Commercial Aviation Report, which is now part of the Flight International family of publications) and Armed Forces Journal, a defense magazine. Leeham Co. partners with Ernest Arvai of the Arvai Group and Addison Schonland of Innovation Analysis Group to undertake projects and special reports. For more information see www.leeham.net.

Addison Schonland heads Innovation Analysis Group, an aviation focused market-research and consultancy based in the United States, and has worked with aircraft manufacturers, engine manufacturers, airlines and the air travel sector. Dr. Schonland has been an innovator in new media, and publishes a successful aviation blog and on-line information resources.

He holds degrees in Sociology, Economics and Finance for the University of Cape Town, South Africa and a doctorate in business administration from Rushmore University. He was previously with PA Consulting Group and has been involved with commercial aviation for over twenty years. Additional information can be found at www.iag-inc.com

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