The Dynamic Regional Jet Market

AirInsight

April 2011

Contents

Background

What is a Regional Jet?

The definition of a regional jet would typically include the fact that it is a twin turbofan engined airliner with a maximum of 100 seats. Interestingly the generally accepted first regional jet is thought to be the Yak-40, which was introduced in the Soviet Union, flying for Aeroflot in 1968. It is rather interesting that the Soviets were significantly ahead of the west in developing this category of aircraft. But there were other important aircraft of slightly larger size such as the Sud Aviation Caravelle and the Fokker F-28. This segment has been something of a tough area for aerospace companies. Teal Group's Richard Aboulafia[1] has termed this segment as a graveyard for airliners.

The purpose of the regional jet was to replace turboprops serving small communities and connecting these communities to larger hubs, as well as offer city to city service, bypassing hubs. When fuel costs were low these aircraft were attractive. With airline deregulation in the United States, airlines were frantic to find any capacity to drive traffic through hubs and connect communities. These small jets offered capacity that could be deployed quickly.

The regional jet segment really exploded in 1989 when Bombardier in Canada stretched its Challenger business jet into a small airliner seating 50, known then as the CRJ100. Bombardier followed up with the CRJ200 which also seated 50, but had more efficient engines. Bombardier sold 1,054 of these regional jets.

Bombardier did not have this market to itself for long. Brazil's Embraer saw the opportunity and developed its ERJ135 (37 sets) and ERJ145 (50 seats); the latter proving to be the more popular of the two. The ERJ was launched in 1989 and to date Embraer has sold over 990 ERJs.

Today the 50-seaters have grown unpopular because of higher fuel costs. The regional jet segment is better defined at between 75 and 100 seats. This is the new "sweet spot". We will enlarge on this idea below.

[1]Telephone interview

The following table lays out the regional jet fleet in the United States and the relative seating capacity.

OEM	Model	Aircraft	Seats	Capacity	
				Seats	Share
Bombardier	CRJ 100/200	672	50	33,600	31%
59%	CRJ 700/705	252	70	17,640	17%
	CRJ 900	139	86	11,954	11%
Embraer	ERJ 135/140	101	37	3,737	3%
40%	ERJ 145	519	50	25,950	24%
	E-170/175	166	70	11,620	11%
	E-190/195	22	106	2,332	2%
		1,871		106,833	

Segment Dimensions

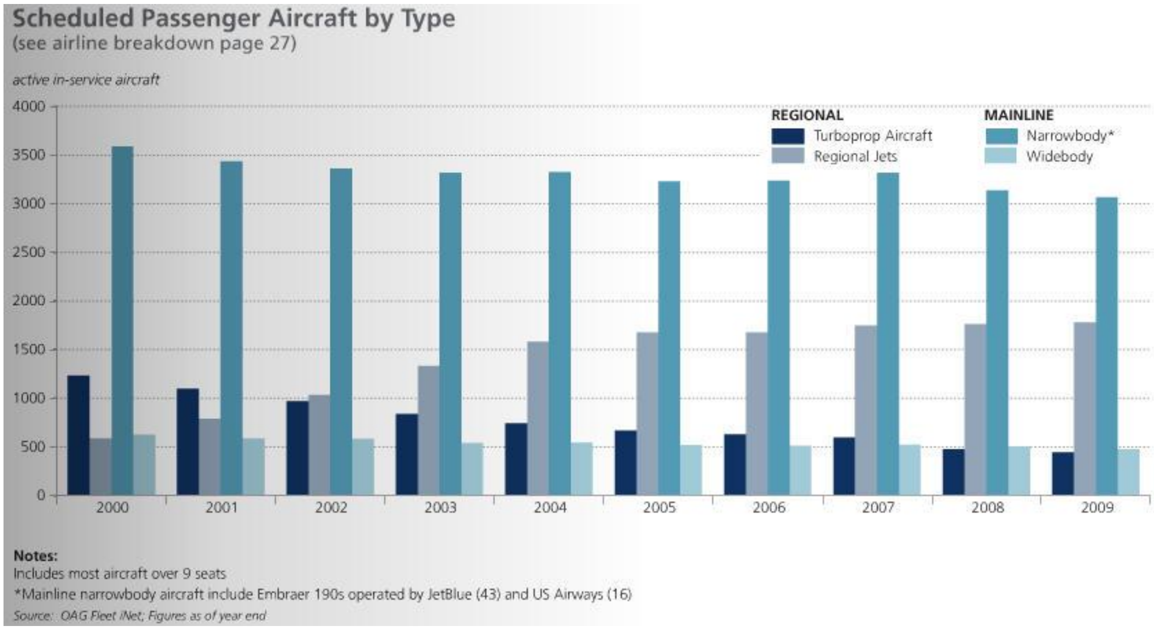
The regional jet segment consists of at least 2,000 aircraft. The rapid ascent of Bombardier and Embraer form the lower end and the success of Airbus' A319 at the upper end led to demise of Fokker. Fokker is often thought to be the first Western regional jet builder. Bombardier decided not to buy the company, which may have been a hasty decision given the success of Embraer's even larger E-jets.

To get an idea of the dimensions of the regional jet market, we decided to cite data from the United States Regional Airline Association (RAA). The RAA has 62 member airlines. They fly 160 million passengers per year with aircraft averaging 55 seats and typically fly 457 mile legs. This means that, in the United States, regional airlines fly 25% of all air passengers and, crucially, 75% of United States communities rely on regional airline service for their *only* scheduled air service. The table below provides a summary of key data defining the extent of the RAA's member airlines.

	1980	1985	1990	1995	2000	2005	2009
Carriers	247	190	153	123	91	75	62
Enplanements	14.69	26.99	41.49	58.31	82.49	152.55	159.45
RPM	1.89	4.7	8.03	12.64	24.38	67.4	72.91
ASM	4.01	10.07	15.04	25.48	42.81	95.58	97.61
LF	47.2%	46.6%	53.4%	49.6%	57.0%	70.5%	74.7%
Departures	2.26	3.23	4.12	4.89	4.55	5.43	4.81
Avg Trip	129	174	194	217	296	442	457
Avg Capacity	16	26	24	30	37	50	55
Fleet flying hrs	1,474	2,118	3,386	3,817	5,943	5,714	5,146

The table shows that there are far fewer airlines than in 1980. But as traffic has risen, these airlines have dropped 19-seaters, then dropped 35-seaters and moved up to larger airplanes. Yet as major airlines have kept moving traffic on to regionals, load factors have remained strong. Regionals have progressively flown ever longer sectors and flying hours have risen in concert.

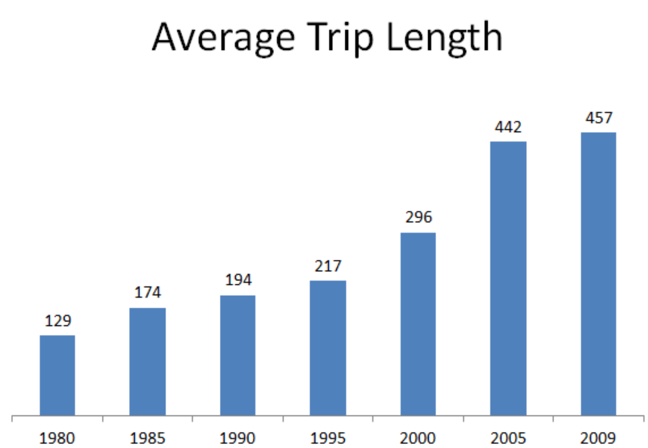
To further underscore the impact regional jets and the airlines that operate them are having, RAA provides this interesting chart.



As the chart shows the only real growth among airline fleets in the United States is in the regional jet segment. It would seem the data highlights a trend to smaller aircraft, even as regional jet fleets have grown in numbers and capacity while major airlines are moving to fewer single aisle jets. The trend underscores what regional jet OEMs have been saying - smaller jets offer great economics and better flexibility than mainline airliners.

History & Perspective

As the chart illustrates, regional airlines have grown rapidly in importance within the United States. As mainline airlines have cut back fleets and costs, their regional partners have become relatively more important.



Source: RAA

In an earlier AirInsight study we described what we see as a renaissance in the turboprop airliner market; the regional jet market is also seeing changes. If turboprops are getting bigger - as we expect - and starting to approach the 75 seat segment, regional jets will grow in size to the 100 seat segment. Traditionally this segment was known as the Trunkliner and an early pioneer of this capacity was the legendary McDonnell Douglas DC-9.

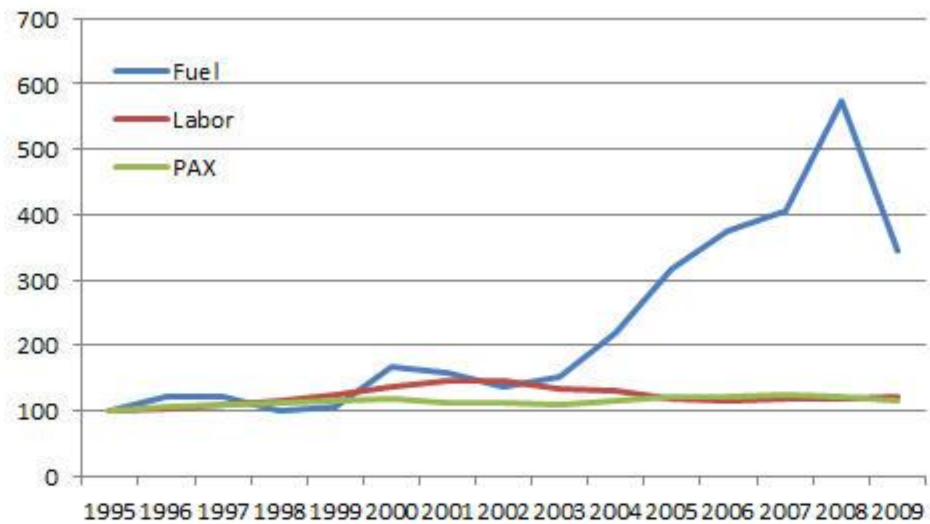
Fuel and Labor

Airlines are run in a way similar to supermarkets. Customers pay for services in advance, while the airline pays its vendors anywhere around 120 days after the flight. This means an airline sits on a cash pile for some three months. Cash management is a key activity and is one example of how complex managing an airline is.

The airline sells a seat for a fixed price with future delivery but its costs vary, and when volatility increases a projected profit quickly can become a loss. Two big cost inputs for airlines are fuel and labor.

Using data from the US DoT Form 41 provides the following chart. Using 1995 as a base year, we can see that even though labor costs have grown marginally, fuel costs have played havoc on costs. Even traffic grew marginally in the period. It is little wonder then that the US airline industry had to enter a period of painful cuts and restructuring.

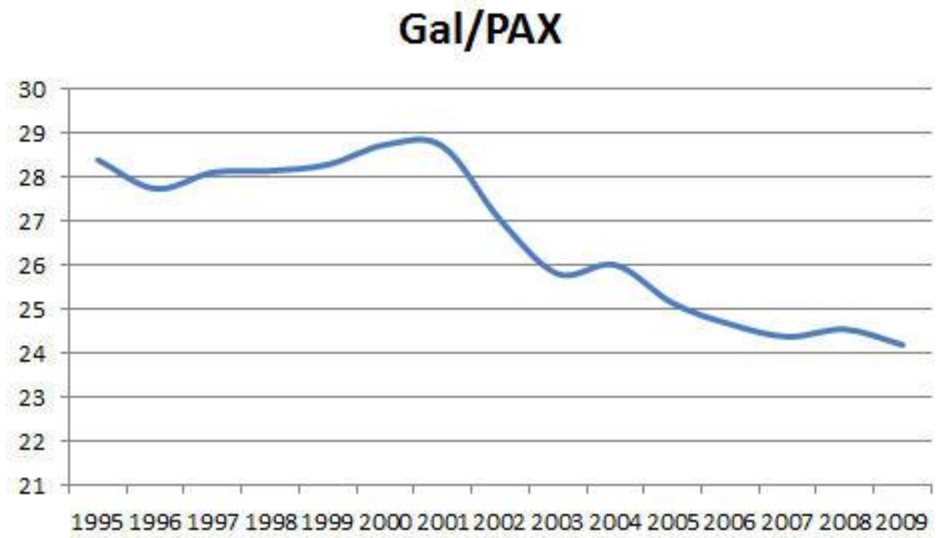
The chart also lays out the case for airlines being aggressive users of fuel hedges. But these hedges tie up scare capital and as we can see, traffic growth has been good but perhaps insufficient to offset the explosion in fuel costs. Therefore, hedges may have been out of the reach of smaller airlines.



Source: US DoT Form 41

The US airline industry has been successful in improving fuel efficiencies. The following chart illustrates the improvement in fuel burn per passenger between 1995 and 2009. This reduction represents a 14% improvement in fuel efficiency.

But the proportional improvement in fuel burn does not match fuel cost increases. The following chart illustrates the amount of fuel burned per passenger - fuel burn improved, but using larger aircraft means that relatively more seats can be sold at marginal extra fuel burn. The larger aircraft simply provide better fuel burn per passenger. This is an impetus to drive airlines to larger aircraft.



Source: US DoT Form 41

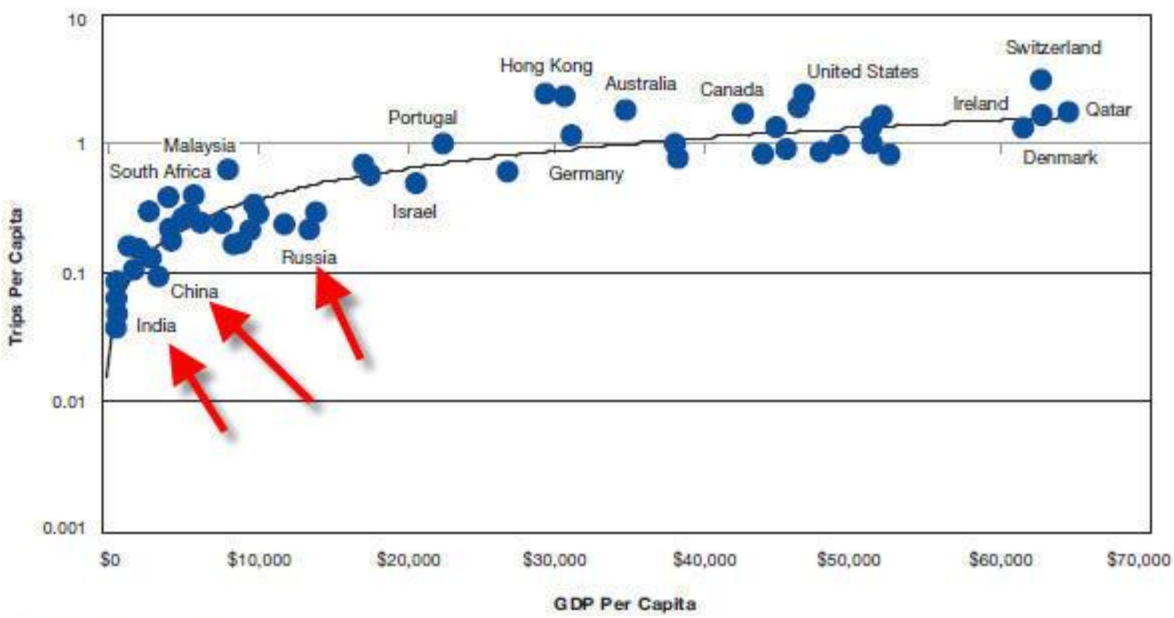
Airlines have to keep at cost reductions relentlessly. Whereas fuel costs were 12% of total expenses in 1995, this rose to 27% by 2009. Clearly the industry has to drive down its costs and this provided encouragement to parking or retiring older and smaller aircraft. Considering that in 1995 the average stage length was 839 miles, the industry achieved over 0.034 miles per gallon per passenger and by 2009 the industry was operating at average stage lengths of over 1,100 miles at 0.021 miles per gallon per passenger. This is a remarkable 38% improvement and demonstrates why the airline industry can fairly point to its fuel efficiency and safety record - it is greener and safer to fly.

Looking Forward

Air travel is increasingly a commodity - not just in developed economies. The chart below illustrates global propensity to travel. We have highlighted three nations that bear attention. These three nations are below the curve, meaning they are relatively low air travel consumers, for a given income level. We expect that to change, because travel demand rises with perceived wealth. For example, note the location of Qatar at the far end of the curve.

That these three nations are important is underscored by the fact that all three either have or are about to develop national civil aerospace programs. The importance of a vibrant air travel sector is not lost on these nations. The propensity to travel increases exponentially in markets where GDP per capita is below $15,000 per year and is directly linked to changes in GDP per capita, a common occurrence in developing markets. For example we have seen the migration of people seeking jobs to job opportunities; the Indian sub-continent to the Gulf is an example.

Propensity to Travel



Source: IHS Global Insight, MIDT data, Bombardier Analysis

Growth Opportunities

In 2009 IATA reported that intra-Asia-Pacific air travelers surpassed those within North America to become the world's largest air travel market. There is little doubt this trend will continue. The chart from The Economist serves to illustrate a pervading view on the way the air travel market will evolve.

Top 5 World Economies Nominal GDP (US$)

Rank	2009	2019	2029
1	USA	USA	**China**
2	Japan	**China**	USA
3	**China**	Japan	**India**
4	Germany	Germany	Japan
5	France	**India**	Germany

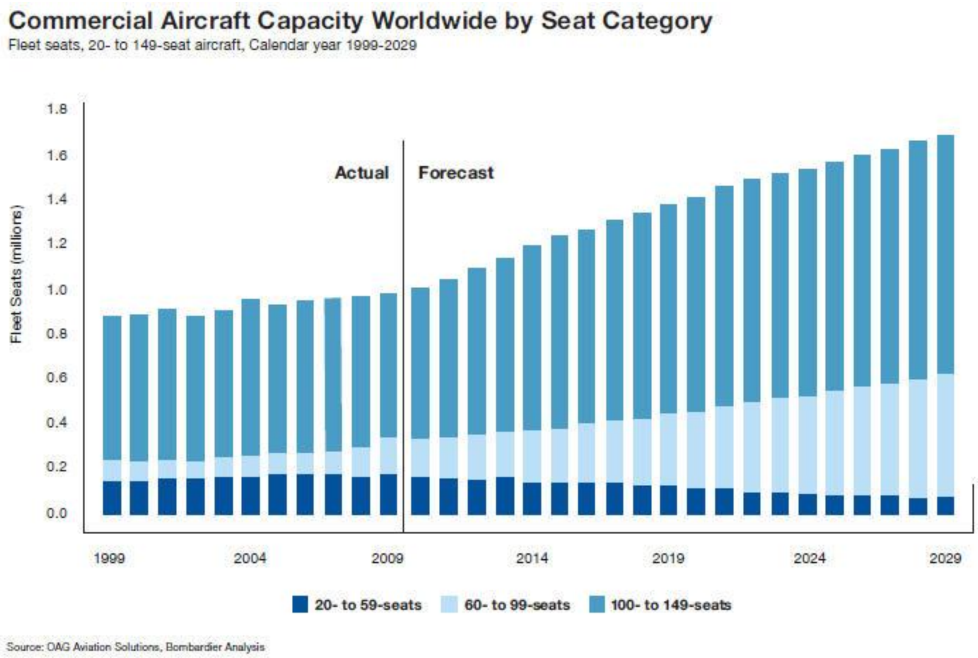
Source: The Economist

China and India are expected to have relatively robust GDP growth rates and travel demand. China should experience an economic growth rate of over 7% for the next 20 years and India should see over 6% for the same period. This strong growth rate, combined with a rising propensity to travel among a developing middle-class, should lead to increased air travel demand.

It is important to understand that in the emerging markets we are likely to see two types of growth in aviation demand. The first is the classic demand from big cities, where critical mass ensures these communities keep their hub status. But when looking at nations like China and India, where governments are determined to ensure rapid growth occurs in many centers within their countries, we expect to see aviation demand mushroom all over. It won't only be the established communities. It is these "new" aviation centers that are going to be highly attractive business opportunities for regional jets. Only the hub cities will attract the VLAs like the A380 and 747.

The market for 50-seat regional jets has matured. The aircraft will continue to feed hubs in the USA and Europe, but will support regional aviation development in Asia, Russia/CIS, Mexico, Africa and South America. Indeed, as Bombardier suggest in their market forecast, "In particular, developing markets will offer considerable opportunities for pre-owned 50-seat regional jets as they grow their airline industries."

The following chart was published by Bombardier and illustrates not just anticipated industry growth, but the evolution within the regional jet segment. Bombardier and Embraer both concur on a swing to larger regional jets, hence their focus on these projects.



Embraer forecasts demand for 6,875 new jets in the 30 to 120-seat capacity segment over the next two decades, with a total market value estimated at $200 billion. The company projects 2,895 aircraft will be delivered between 2010 and 2019 with the remaining 3,980 units to be delivered between 2020 and 2029. However, the most active segment within the regional jet business is likely to be between 70 and 150 seats.

Existing fleet

Regional airlines appear to be shifting fleets to larger aircraft, whether turboprop or jet. The larger aircraft offer more capacity and lower operating costs per seat mile. This means that while this study focuses on regional jets, it bears mentioning that the regional aircraft segment is splintering.

Older 50-seat regional jets are typically moving out of airline fleets in North America, spending some time in storage and then moving overseas. In fact, Air France's regional service recently placed four of its E-145s with Air Namibia. So the phenomenon is not unique to North America, rather it appears this is occurring in all develop air travel markets.

As of June 2010 parked civil aircraft totaled 1,912, which was up 57% from a ten year low of 1,211 in 2007. It is likely that the older generations of the parked aircraft will not return to commercial passenger service.

Emerging Technologies

Going Green

Although aircraft CO^2 emissions account for ~2% of total global greenhouse emissions, civil aerospace and airlines are stepping up efforts to develop products with new technologies that will reduce fuel consumption, increase efficiency and generate fewer emissions.

The cost pressure on aerospace and airlines is driving a move that is likely to see older airliners retired before they have lived out their commercial lives. Rising fuel costs mean that older aircraft simply have economics that no longer work. During the last oil spike, many airlines parked older aircraft - many of which were relatively modern. After oil prices eased, few of these aircraft came back into service. Indeed, airlines were highly selective and only brought back capacity they needed and were sure they could operate profitably. Among US airlines the capacity constraint is cited as a key reason many airlines are once again profitable.

Biofuels

One the industry's hottest discussion topics is the need to reduce dependence on fossils fuels. The costs are volatile and there is growing demand to become less polluting. Of these two factors, we believe the cost input is by far the greater impetus to move towards biofuels. Airlines require stability in terms of input costs - absent any reasonable stability the industry is unable to price seats effectively. This problem quickly becomes everyone's concern, from passengers to employees and even governments that depend on the bountiful tax revenues the industry generates.

Boeing estimates biofuels could reduce aviation-related greenhouse-gas emissions by 60% to 80%. Their solution might include blending algae fuels with existing jet fuel[2]. IATA's goal is for its members to be using 10% alternative fuels by 2017[3]. The latest oil price spike could only serve to accelerate this effort,

[2] http://seattletimes.nwsource.com/html/boeingaerospace/2003858756_boeingenergy30.html
[3] http://www.iata.org/whatwedo/environment/Pages/alternative-fuels.aspx

perhaps making it happen sooner than IATA's goal. Even if the oil price were to abate quickly, the industry has learned two harsh lessons within two years. Its dependence on fuels is an Achilles heel that must be addressed. No matter how efficient the engines and airframes, they will require fuel to fly. Consequently the need to radically improve fuel costs must be addressed.

The challenge facing the industry with a switch to biofuels is the need for such a fuel to literally be a "drop-in" solution. Meaning such a biofuel solution must fit into the current industry fuel infrastructure. Tests on biofuels have been conducted by many airlines, the OEMs and even the US Air Force. It should be noted that Embraer's crop duster has been using ethanol as its fuel for years. So even though the biofuel issue has become more a public debate, it is by no means a recent invention.

Fortunately the tests have been positive; as far as we are aware no aviation biofuel test has not met its goals. It would seem the first phase of a biofuel roll out could be a 50/50 blend with fossil fuels. But before the industry can move forward wholesale and utilize biofuel blends, government safety regulators have to approve such use.

Meanwhile Airbus and Lufthansa announced[4] their intention to operate the world's first ever scheduled commercial passenger flights using biofuel in the first half of 2011. This flight will utilize a biofuel blend made from 50% Hydro treated vegetable oil and traditional aviation fuel. Daily flights should begin in April 2011 and will initially continue for a period of six months. The biofuel is being provided by Finland's Neste Oil, under an agreement with Lufthansa. The fuel will be produced from sustainable feedstock sources to make sure that the bio-feedstock does not compete for food, water or land.

It is clear that the demand for a biofuel solution is little short of revolutionary for commercial aviation. Its impact will be tremendous and possibly as far reaching as the invention of the turbine engine itself. Circumstances are sure to accelerate the process of deploying biofuels and blends.

However one voice reflects a view that commercial aviation, especially within the United States, does not want to embrace change as quickly as it might. San Diego based Sapphire Energy's CEO Jason Pyle sees a less bright future, he is quoted[5] as saying: commercial aviation is "not an attractive customer" for his company's 'Green Crude' which is precisely the type of drop-in solution the industry needs. Sapphire's transportation fuel is derived from algae. Sapphire was awarded over $100 million by the US Government as part of a program to help reduce American dependence on foreign oil. Sapphire has carried out tests using a 50/50 blend of its fuel in co-operation with Continental Airlines and Japan Air Lines, so it is familiar with the industry and its risk-averse nature.

---

[4] http://www.airbus.com/newsevents/news-events-single/detail/lufthansa-and-airbus-launch-worlds-first-passenger-bio-fuel-flights/search-results-1/?tx_ttnews[monthfrom]=0&tx_ttnews[monthto]=0&cHash=54813c84243d90dcfe96c6094a0ba374

[5] http://www.flightglobal.com/articles/2011/03/10/354225/airline-industry-last-in-line-to-sign-up-for-algae-fuel-sapphire.html

Engines

Regional jets are clearly under the same pressure as other aircraft. The search for lower costs is never ending - and this means lower weight, lower fuel burn and better economics. In terms of breaking down the cost impacts, NASA has a research project[6] looking at the next three generations of aircraft, called N+3. The projected gains in fuel burn for a conventional configuration aircraft, EIS in the period of 2030-35+, is projected to be of the order of 50%, of which 20% would be due to new engines, 12% due to airframe improvements (structure + aerodynamics + etc.), and 18% to operational procedures made possible by NextGen (ATC) improvements.

But this is a long way off. Looking at the more immediate future, regional jets face the identical challenges of large airliners. Fortunately regional jets are likely to see newer engines before the larger aircraft. For example, Mitsubishi's MRJ will use Pratt & Whitney's geared fan engine and is expected to have its first flight in 2012. By comparison, the Bombardier CSeries, using a similar, but larger, engine is expected to fly in 2013. The other key engines in the segment come from GE and PowerJet.

Pratt & Whitney

This company has developed its line of geared fan engines, now known as PurePower, but forever nicked named the GTF. Using a gearbox between the fan and the rest of the turbine, the engine allows for both parts to operate at optimal speeds. This allows for much better fuel burn, a higher bypass ratio (~12) with significantly lower noise. The engine has caused some disruption. By being selected for Bombardier's CSeries, the engine enables Bombardier to threaten Airbus and Boeing at the lower end of the mainline commercial jet market. Airbus reacted by adopting this engine for its A320neo program.

It is generally thought that but for this engine, Bombardier's CSeries might never have been launched. Indeed, the CEO of IRKUT in Russia said that without this engine they could never have launched the MS-21 project.

Pratt & Whitney developed a smaller version of their GTF that can be used on regional jets. Mitsubishi is the launch customer of this engine, with between 15,000 to 20,000 pounds of thrust, depending on the MRJ variant. We understand that Embraer is considering this engine for its own E-Jet update and a larger airplane in the <150 seat segment. The recent announcement from ILFC to order 60 GTF powered A320neos plus the probability that the large IndiGo NEO order will also be GTF powered certainly puts the wind at Pratt & Whitney's back.

The GTF's promise has been well reported. The company believes its new engine will reduce noise by 75% and cut fuel by over 15%. In addition it promises substantially lower MRO costs. For some the engine's promise is too good to be true. Even as analysts note the company's encouraging press releases and positive news flow via trade press, a healthy dose of skepticism is not unreasonable. We have visited Pratt & Whitney and seen the engine and spoken with the firm's project leadership. We

[6] http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20100021005_2010021539.pdf

have also spoken with airlines that have been pitched by Pratt & Whitney. Everyone we have spoken with has come away from seeing the GTF's numbers suitably impressed. It looks to be the quietest of the next generation engines. This is a very important factor considering it will power smaller jets that perform between five and eight operations daily. It is likely that GTF aircraft will not be held to operational restrictions at noise sensitive airports. It has 6,000 fewer airfoils than conventional turbofans making MRO costs lower. Even with a dose of skepticism the engine looks remarkable.

Pratt & Whitney is clearly the new engine leader in the regional jet business. It has a large and growing footprint as one could count the 100 seat CS100 and the MRJ in the initial user base. It is also is the leading provider of turboprop engines. Together this means Pratt & Whitney has a very significant impact on the regional airline business.

General Electric

GE offers the CF34, which is a civilian turbofan developed by GE from its TF34 military engine. The CF34 is used on Bombardier's CRJs, Embraer's E-Jets, and COMAC's ARJ21. There are various models of this engine. The engine's latest variant is the -10 which has a thrust between 18,000 and 20,000 pounds. This enables the engine to power regional jets between 50 and 105 seats. The engine first saw civil use in 1983 on the Bombardier 601 business jet. In 1992 it went on the first Bombardier CRJ. In true GE tradition, the engine has been tweaked ever since. The first iteration had 9,220 pounds of thrust and nearly thirty years later power is more than doubled.

There is almost certainly going to be a replacement to the CF34 that builds on the GEnx and LEAP-X engine experience. Regional jets can be regarded as home turf for GE and they will not ignore this important segment of aviation.

In a recent interview given by GE to AirInsight we learned they are indeed working on a NG34. The CF34 engine has had a very influential role among regional airlines. GE started its NG34 technology development program. This is similar to the technology development programs that CFM has for its engines (Tech56). The NG34 technology development program involves GE's eCore - which is the latest core that will be part of CFM's LEAP-X engine and GE's TechX engine for business aviation (recently selected for Bombardier's Global 7000/8000). This means GE will have common architecture on the cores for next-gen narrowbody, regional and business jet applications.

GE's eCore technology should offer ~15% better fuel efficiency than current technology. It will have industry leading high pressure ratio compressor with advanced materials and 3rd generation 3-D aero design for enhanced reliability and durability and improved fuel consumption. eCore incorporates the lean burn TAPS II combustor (similar to the GEnx) for lower emissions, producing lower NOx emissions throughout flight envelope compared to current engines. It will also use advanced materials and cooling design in the high pressure turbine for enhanced durability and improved performance. Core testing for eCore is already underway.

The overall goal for the NG34 technology program is to lower operating costs by 10-15%. Reliability is a key attribute for the high cycle regional jet environment and GE recognizes that the next generation

CF34 engine must maintain the reliability of current CF34s. The CF34 has set the standard for reliability for RJ engines. The NG engine needs to be simple (fewer parts) and be robust.

Timing on the NG34 technology program depends on both the development at GE but is also driven by applications. GE believes it will be able to support new airplane applications anticipated to hit the market in the 2015+ timeframe. This timeframe allows for the NG34 to absorb technology and IP from the GEnx and LEAP-X.

PowerJet

PowerJet is a 50-50 joint venture held by Snecma (France) and NPO Saturn (Russia) created in July 2004. The company manages the SaM146 program including studies, production, marketing and after-sales support. The firm touts its SaM146 as the only “fully integrated propulsion system designed, from the ground up, for the new generation of regional jets.” The SaM146 develops 13,500 to17,500 pounds of thrust and covers the power requirements for aircraft carrying 70 to 120 passengers. This thrust range reflects to evolution in how regional jets are viewed - 70 seats is the new 50.

To date the engine is only being used on the SuperJet. However there are other programs that might exploit the engine as well. But PowerJet will have a tough time competing with the two well established OEMs, CFM and Pratt & Whitney.

Avionics

This area of an aircraft program is both a potential source of tremendous opportunity and at the same time could be a threat. On the one hand the rapid progress made in IT has enabled every industry to rapidly deploy technology to drive staggering amounts of information into decision making processes. But even as decision processes are supposedly better because of much improved information, systems that generate this flow of information have created their own challenges.

In an interview with Embraer’s Mauro Kern we learned the company’s next airliner would be developed as a node on a network – Mr Kern referred to this as the “intelligent airplane”. It is an excellent idea. Bombardier is also planning to make much use of connectivity for its upcoming CSeries. All Airbus airplanes today are pre-wired for SSB in the event the airline customer wants to enable narrow band connectivity. Airbus has embraced this thinking in light of the AF447 disaster. Clearly that event acts as a lesson for the entire industry, because had the aircraft been “connected” in real-time, Air France (and Airbus) might have had considerably more information than the few seconds of ACARS data transmitted in the final seconds of flight.

So the attraction of significantly better avionics is clear. But, now for the other side of the argument. These systems have grown remarkably in complexity. As reported in FlightGlobal, connectivity has its drawbacks[7]. The problems Boeing faces with news that flight deck

[7] http://www.flightglobal.com/blogs/runway-girl/2011/03/breaking-boeing-confirms-wi-fi.html

interference has been traced to on-board WiFi[8]. Though memories fade, it is important to remember that on-board passenger entertainment systems have been fingered before in serious accidents – for example Swissair SR111.

So even as one views the marvelous future information technology offers, in the aviation sector there are good reasons to be a tad leery. Yes technology like avionics can do marvelous things. For example RNP and next generation ATC all require extensive use of technology. EFBs are wonderful tools for pilots. But as we learned in speaking with a captain at a large European airline, EFBs are also something to be careful of. For example EFB 2 is an acceptable solution for this airline, whereas EFB 3 is not. The key difference? EFB 2 updates decision support information for the crew, and they can then decide how to react to the updated information – like weather for example. But EFB 3 is fully automated and data updates go directly to the flight computer as opposed to an unconnected laptop on the flight deck. Imagine the consternation by the crew when they see the aircraft making course changes without any input from them! The captain's fears are easy to understand.

But for those who are under the sway of technology will surely argue that computers are better than humans. Yet time and again we have seen superb crew training achieve miraculous results which we believe a computer could easily have ruined – for example Qantas QF31 in November 2010.

New Players

Airlines

The regional jet market offers an opportunity for small airline to grow. Turboprop operators naturally look at the next segment up as natural growth paths. There are very few airlines that go the other way, for example Horizon Air in Oregon, which is moving away from regional jets to focus on turboprops.

Given the nature of regional airlines, serving smaller communities, competition is often not as intense. Smaller markets do not attract as much attention. After all, airlines are a volume business and with limited resources air service tends to be geographically regionalized.

In terms of developed aviation markets, regional airlines have an ever tougher time because they are squeezed by their role as feeders for larger airlines. Since their labor costs are appreciably lower, regionals get pushed into serving routes deemed marginal by larger airlines. There is a large wage differential between mainline and regional pilots. This wage gap has led to nasty fighting among pilots and airlines[9].

[8] http://www.flightglobal.com/blogs/runway-girl/2011/03/boeing-conducts-broad-avionics.html
[9] http://www.centreforaviation.com/news/2010/12/31/labor-rates-could-prove-disastrous-in-us/page1

According to the US Air Line Pilots Association, their average major airline member Captain is 50 years old, with 18 years seniority and makes $182,000 a year. A non-major airline Captain is 41 years old with 10 years of seniority and makes $70,000 a year. The average ALPA First Officer member at a major airline is 43 years old with 10 years of seniority and makes $121,000 per year, while an ALPA non major First Officer is age 35 with 3 years of service and makes $33,000. So the wage gap is wide. On average, annual wages a regional pilot is approximately $30,000. It is lower for pilots with less seniority and higher for pilots who are captains and have seniority. With wages at regionals so much lower, it is no surprise that major airlines make increased use of regionals, especially on marginal routes.

In less developed aviation markets there are likely to be much better opportunities for pilots. For example, countries like Vietnam or numerous African markets. In these situations, regionals can grow more easily. But invariably they need to reach an accommodation with a state owned major airline. State ownership of an airline has earned a well-deserved raspberry - it is the exception that does not suffer from corruption and "jobs for pals". So while the opportunity exists in these markets to grow and build a business, there are exogenous factors to be wary of. An example of an airline successfully managing around these challenges is Fly540[10] in Africa. So it can be done, and opportunities are probably better in less developed air travel markets.

Emerging OEMs

Rekkof

The remnants of what was Fokker are still in a state of flux. The firm has plans to update the F-70 and F-100 with a host of features found on newer aircraft. But the firm has run into a capital crunch - it has no backers and absent the financial wherewithal, the company is stuck with plans for planes. Clearly the lack of progress in acquiring finance speaks loudly that the firm's future as an OEM is increasingly a dream. This is unfortunate as the Fokker brand is an industry legend. The company created some marvelous aircraft. Indeed when looking at a recent article on what appears to be Boeing's thoughts on replacing the 737 or 757, one can see how influential Fokker was in ideas it was developing with McDonnell Douglas some years back[11].

[10] http://www.fly540.com/fly540.html

[11] http://atwonline.com/aircraft-engines-components/news/boeing-focusing-twin-aisle-concept-737-replacement-will-be-announce

Current OEMs

Bombardier

This firm has a good claim on the invention of the term regional jet. While others came before with smaller jets, like Sud Aviation and Fokker, it was Bombardier that seemed to capture the genre in 1992. Today, with over 1,300 Bombardier CRJs flying, it has become the arguably most successful regional aircraft program in the world.

The tremendous success of the CRJ1/200 led to airlines asking for more capacity that would allow for growth while offering lower costs. Bombardier responded with new variants of the CRJ; namely the CRJ700, CRJ705 and CRJ900. These airplanes were substantially redesigned from the first generation CRJs. The CRJ700, CRJ705 and CRJ900 use the same engine, allowing for commonality and reduced maintenance costs. All versions of the Bombardier CRJ can be flown by the same pilot pool, substantially reducing training costs. Bombardier is about to introduce a 100 seat version of the CRJ, known as the CRJ1000. An early customer for the airplane, Air Nostrum, reports great satisfaction with its performance.

While on to a good thing, Bombardier went on to develop newer versions of their CRJ, known by the same names, with addition of the words NextGen after each name. The NextGen versions have a redesigned cabin, lower emissions and even lower operating costs (8%-15%).

The CRJ1000 is almost certainly the nadir of the CRJ project. Bombardier is offering its CSeries as the next step up. The CRJ has run its course and Bombardier has to rethink its product line as a consequence. It can continue with the current CRJs for a while yet. Indeed, when the NG34 engine becomes available we could see the CRJs making use of this engine. But there are unlikely to be any further stretches of the CRJ airframe.

The following table lists the sales data on the CRJ next generation. As we will see with Embraer, Bombardier has developed a broad geographical customer base. The top nine customers account for over two thirds of the orders. By comparison Embraer's top nine customers account for 53% of orders, making their customer base slightly less top heavy. This becomes an issue when one considers the impact airline consolidation is having. Note the Northwest Airlines listing in the sixth row below – the airline no longer exists. Adding these numbers to the acquiring airline Delta in the second row, means that Bombardier has 16% of its orders in the hands of one customer. Note then that in row one

SkyWest is a Delta connection airline and one can see that in fact Bombardier has nearly a third of its orders in one airline group.

	CRJ 700		CRJ705		CRJ900		CRJ1000		Conc.
	Ordered	Delivered	Ordered	Delivered	Ordered	Delivered	Ordered	Delivered	
SkyWest	79	75	0	0	21	21	0	0	15%
Delta Connection	30	30	0	0	44	44	0	0	11%
Mesa	30	20	0	0	38	38	0	0	10%
American Eagle	47	42	0	0	0	0	0	0	7%
Air Nostrum	0	0	0	0	11	11	35	5	7%
Northwest Airlines	0	0	0	0	36	36	0	0	5%
Lufthansa CityLine	20	20	0	0	12	12	0	0	5%
BRIT AIR	15	15	0	0	0	0	14	4	4%
COMAIR	20	20	0	0	0	0	0	0	3%
Horizon	20	20	0	0	0	0	0	0	3%
GECAS	17	17	0	0	0	0	0	0	3%
Air Canada	0	0	15	15	0	0	0	0	2%
Lufthansa/Eurowings	0	0	0	0	15	15	0	0	2%
GoJet	14	14	0	0	0	0	0	0	2%
ASA	12	12	0	0	0	0	0	0	2%
SAS Scandinavian	0	0	0	0	12	12	0	0	2%
Air One	0	0	0	0	10	10	0	0	2%
Iraq	0	0	0	0	10	4	0	0	2%
Pluna	0	0	0	0	10	10	0	0	2%
Felix Airways	8	2	0	0	0	0	0	0	1%
Libyan	0	0	0	0	8	5	0	0	1%
Lufthansa	0	0	0	0	8	0	0	0	1%
US Airways	8	8	0	0	0	0	0	0	1%
Tatarstan	0	0	0	0	6	2	0	0	1%
Undisclosed	6	2	0	0	0	0	0	21	1%
Adria Airways	0	0	0	0	5	4	0	0	1%
Maersk	5	5	0	0	0	0	0	0	1%
Arik Air	0	0	0	0	4	4	0	0	1%
My Way	0	0	0	0	4	4	0	0	1%
Atlasjet	0	0	0	0	3	3	0	0	0%
Estonian Air	0	0	0	0	3	0	0	0	0%
Shandong Airlines	2	2	0	0	0	0	0	0	0%
Macedonian	0	0	0	0	1	1	0	0	0%
Oasis/Air Canada	0	0	1	1	0	0	0	0	0%
Styrian Spirit	1	1	0	0	0	0	0	0	0%
Tuninter	0	0	0	0	1	1	0	0	0%

Air Dolimiti	0	0	0	0	0	0	0	0	0%
Air Littoral	0	0	0	0	0	0	0	0	0%
Air Wisconsin	0	0	0	0	0	0	0	0	0%
Austrian arrows	0	0	0	0	0	0	0	0	0%
British European	0	0	0	0	0	0	0	0	0%
China Eastern	0	0	0	0	0	0	0	0	0%
Cimber Air	0	0	0	0	0	0	0	0	0%
DAC AIR	0	0	0	0	0	0	0	0	0%
The Fair	0	0	0	0	0	0	0	0	0%
Independence	0	0	0	0	0	0	0	0	0%
JAL	0	0	0	0	0	0	0	0	0%
Kendell/Ansett	0	0	0	0	0	0	0	0	0%
Lauda Air	0	0	0	0	0	0	0	0	0%
Malev	0	0	0	0	0	0	0	0	0%
Midway	0	0	0	0	0	0	0	0	0%
Saeaga	0	0	0	0	0	0	0	0	0%
Shanghai Airlines	0	0	0	0	0	0	0	0	0%
South African	0	0	0	0	0	0	0	0	0%
Southern Winds	0	0	0	0	0	0	0	0	0%
	334	305	16	16	262	237	49	30	

Embraer

This company entered the regional jet business by moving up from turboprops and then entered the business jet after achieving success in the regional airliner business.

Announced at the Paris Air Show in 1999 the first E-Jet entered production in 2002, the aircraft series has been a success. Embraer's E-Jets line consists of two models. The smaller E-170 and E-175 are base models, the E-190 and E-195 are stretched models. The models have different engines, wings, horizontal stabilizer and landing gear. The 170 and 175 share 95% commonality, as do the 190 and 195. The two sizes share about 89% commonality, with identical fuselage cross-sections and avionics.

To better understand the relative sizes of the E-Jets, the E-170 compares to Bombardier's CRJ700/5 and the E-175 compares to the CRJ900. Like the CRJ's the E-Jets use the GE CF34 engine. The E-190/5 compares to the CRJ1000. As with the CRJ, the E-Jets could be updated using the NG34 engine when it becomes available.

Among the current high end of the regional jet market, Embraer has a highly compelling offering in the E-170/5 and the E-190/5. These aircraft are competing vigorously and a recent win by Embraer for Alitalia's business is a case worth noting. Embraer was competing with the Russo-Italian SuperJet and won, despite a generally accepted view the Italians would select he "home" team.

Embraer's E-Jets offer 2x2 seating making them among the most comfortable aircraft in the segment. These aircraft were early to the 75-100-seat segment and managed to see off older aircraft that were much less efficient - such as the BAe 146. By the end of 2010 Embraer had delivered 660 E-jets, with options for another 720 and a firm backlog of 249. Of interest to analysts is the fact that among the four models offered, the larger aircraft have proven far more popular at ~61% of orders, 56% of options and ~80% of backlog.

Model	Orders	Options	Deliveries	Backlog
E-170/5	366	316	303	51
E-190/5	561	404	357	198
	927	720	660	249

In terms of the overall program, the table below illustrates the general orders and deliveries for all four programs. As the table shows, the E-Jets have built a strong global customer base for Embraer. Given that airlines like not to make major switches in fleet choices, one would expect Embraer to be well placed to keep its customers when it updates the E-jet with newer engines or even decides to offer a larger aircraft.

	E-170/5		E190/95		Concentration
	Orders	Delivered	Orders	Delivered	
JetBlue Airways			104	44	11%
Republic Airlines	72	72	15	14	9%
Air Canada	15	15	45	45	6%
Shuttle America	58	58			6%
Tianjin Airlines			50	27	5%
Flybe	35	0	14	14	5%
Azul Brazilian Airlines			41	19	4%
Compass Airlines	36	35			4%
US Airways			32	15	3%
Lufthansa CityLine			30	14	3%
LOT	20	20	4	0	3%
Virgin Blue	6	6	18	15	3%
Finnair	10	6	13	10	2%
KLM Cityhopper			22	17	2%
Alitalia	15	6	5	0	2%
Air France Régional	10	10	10	10	2%

Austral Líneas Aéreas			18	3	2%
Saudi Arabian Airlines	15	15	2	5	2%
Copa Airlines			15	15	2%
EgyptAir Express	12	12			1%
Aeromexico Connect			12	7	1%
Air Europa			12	7	1%
TACA			11	5	1%
BA CityFlyer	6	6	5	4	1%
Air Lease			10	0	1%
Nas Air			10	4	1%
J-Air	10	7			1%
Mandarin Airlines			8	8	1%
Niki			7	5	1%
TRIP Linhas Aéreas	5	6	2	0	1%
Star Aviation (India)	7	0			1%
Aero República			5	11	1%
Air Dolomiti			5	5	1%
Kunpeng Airlines			5	4	1%
LACSA			5	4	1%
TAME	2	2	3	3	1%
Kenya Airways	3	5	2	0	1%
Oman Air	5	0			1%
Air Astana			3	0	0%
Baboo			3	3	0%
Airnorth	3	3			0%
Fuji Dream Airlines	3	3			0%
Petro Air	3	3			0%
Air Nigeria			2	2	0%
Arkia			2	1	0%
Augsburg Airways			2	6	0%
LAM Mozambique Airlines			2	2	0%
Montenegro Airlines			2	3	0%
Wind Rose Aviation			2	2	0%
Airlink	2	0			0%
Cirrus Airlines	2	2			0%
Finncomm Airlines	2	2			0%
Gulf Air	2	2			0%
Paramount Airways	2	2			0%
Royal Jordanian	2	2			0%
SATENA	2	2			0%
Air Caraibes			1	1	0%

Air Moldova			1	1	0%
Al Jaber Aviation			1	1	0%
EuroLOT	1	1			0%
Royal Jet			0	1	0%
Total	**366**	**303**	**561**	**357**	

COMAC

COMAC is an abbreviation of Commercial Aircraft Corporation of China Ltd. The company is based in Shanghai, China. The company was created to provide China with commercial aircraft and reduce the nation’s dependence on Airbus and Boeing. Its first project is known as the ARJ21.

People familiar with commercial aviation invariably joke about this aircraft being an updated DC-9. Indeed, but for the engines and winglets it would be tough to distinguish the ARJ21 from a DC-9. But to dismiss this as a copycat aircraft misses the point. Even as the ARJ21 is being flight tested, China is developing the C919. The ARJ21 will be sold to Chinese airlines. COMAC does not need to make a profit on the program. The primary purpose of the project is to develop homegrown IP.

China has an Airbus factory in Tiajian. There are frequent rumors about Chinese attempts at breaching Airbus’ computer network to acquire blueprints and design secrets. Airbus and the Chinese deny this. However China is open about how one does business there. In recent testimony given to the United States House of Representatives by Peter Brookes, a Senior Fellow at the Heritage Foundation, he stated ”In exchange for participating in sharing or co-developing their technology, often with State-Owned Enterprises, foreign firms are given access to current and future business opportunities in China’s market. For all practical purposes, the Indigenous Innovation policy is an effort on the part of Beijing to gain access to foreign intellectual property to improve China’s commercial competitiveness at home and abroad[12].”

That is polite language for what plain speaking might describe as subterfuge. However, China is growing to become the largest economy. Every firm wants to be able to access that market. It might be many

[12] http://www.heritage.org/Research/Testimony/2011/03/Chinas-Indigenous-Innovation-Trade-and-Investment-Policies-How-Great-a-Threat

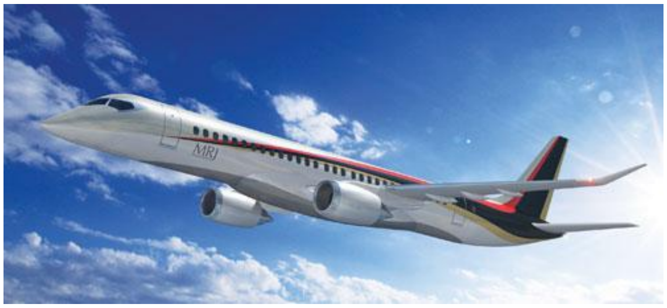
years before China is a first tier aerospace threat to western firms. But there are numerous projects that have western partners. Bombardier works with Shenyang on its Q400 and CSeries. Boeing makes use of China for its 787 project. Embraer wants to grow its current production facility in China.

COMAC is aware of the skepticism it attracts in the West. For a non-Chinese speaker acquiring any official information is very difficult. Requests for information by western analysts are routinely ignored. Without a local Chinese contact information flow depends on what is published through official Chinese media.

The following table illustrates the high concentration (<10%) of non-Chinese commitments to the aircraft. There is no doubt that China will lean on its allies to buy the aircraft on favorable terms. China needs these sales to show its flag, but more importantly, to grow its aerospace skilled workforce. Consequently we could see, for example, Zimbabwe do a deal for the aircraft with exports or mineral rights as payment.

	Orders	Concentration
Henan Airlines	100	42%
Joy Air	50	21%
Shanghai Leasing	30	13%
Shenzhen Financial	20	8%
Shandong Airlines	10	4%
Merkukh Enterprises	9	4%
Xiamen Airlines	6	3%
Shanghai Airlines	5	2%
GECAS	5	2%
Lao Airlines	2	1%
	237	

Mitsubishi



This company was once famous for its Zero fighter. Mitsubishi is developing its MRJ in partnership with Toyota. It will be the first airliner designed and produced domestically in Japan since the NAMC YS-11 of the 1960s and that aircraft was a Hawker Siddley built under license.

The MRJ project is not a large provider of information. One particular item of interest has been the early decision to make extensive use of carbon fiber. Then the company decided they would prefer to move back to traditional aluminum. Mitsubishi is a Boeing contractor on the 787 project and may have seen that carbon fiber scales up well, but does not scale down well.

The MRJ will have a slightly wider and higher cabin than Bombardier and Embraer's competing projects. The aircraft will come in two sizes. The MRJ70 will have a passenger capacity of 70-80 and the MRJ90 will have a passenger capacity of 86-96. The following table lists the MRJ's orders to date.

	Orders	Options
All Nippon	15	10
Trans States	50	50
	65	60

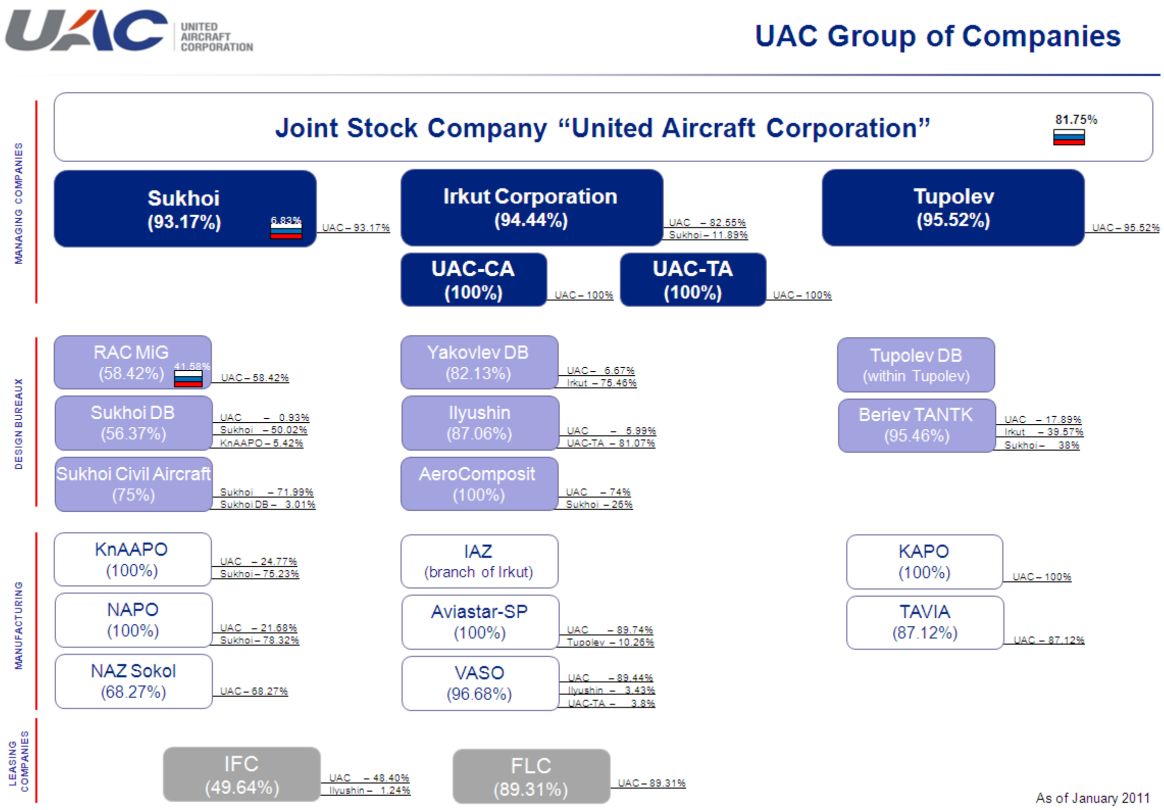
As the table illustrates Mitsubishi has not been particularly successful. There are rumors that Republic Airlines may be in the hunt to buy the MRJ. If this occurs it would make sense as Republic has a big commitment to the Bombardier CSeries and both the CS and MRJ utilize the Pratt & Whitney GTF engine. At the 2010 RAA Convention Mitsubishi officials hinted strongly they are looking at stretching the MRJ to a capacity of approximately 100. Whether any airlines will look at the aircraft is unknown, but airlines do like the idea of a family to choose from.

In Mitsubishi's favor are its heritage and reputation as a source of world class engineering. The same can be said of Toyota. But the field is clearly crowded. The MRJ is a new airplane from essentially a new team. It faces an uphill battle. That the Japanese will see this through there can be no doubt. National pride is at stake. Moreover there is little doubt that the airplane will be of excellent build quality and consequently airlines can anticipate an airplane with high dispatch rates at EIS. Quality is not the problem. But over turning an airline from Bombardier and Embraer is going to be tough and that is what the MRJ faces.

UAC (Antonov)

This company was an attempt by the Russian state to organize its Soviet era multiple aerospace firms into one company. Without central planning, a merged group was the best way to ensure the country maintained its IP base while at the same keep plants open ticking over at low rates of production. It was a way to save Russia's aerospace industry and largely succeeded. They have kept some programs going, while developing some news projects and allowing others to fade away. Looking back this was the least disruptive method to maintain the nation's industry.

As UAC reports: UAC is a "Joint Stock Company" incorporated according to the Decree #140 "On Joint Stock Company United Aircraft Corporation" signed by Russian Federation President Vladimir Putin on February 20, 2006. UAC was registered on November 20, 2006. The Russian Government contributed assets of the largest state-owned Russian aircraft building companies to UAC's charter capital. UAC and its member companies' priorities include design, manufacture, sales, operation maintenance, guarantee and service maintenance, upgrading, repair and utilization of civil and military aircraft.



The table below lays out the various Russian aerospace firms that were combined into UAC. UAC holds the stakes listed below in each of the plants. This chart illustrates just how complex UAC is.

JSC Aviation Holding Company Sukhoi	100.0%
V/O Aviaexport	15.0%
JSC Ilyushin Finance K°	38.0%
JSC Komsomolsk-on Amur Aircraft Production Association named after Yu. Gagarin	25.5%
JSC Ilyushin Interstate Aircraft-building Company	86.0%
JSC Nizhny Novgorod Aircraft building plant SOKOL	38.0%
JSC Novosibirsk Aircraft Production Association named after V.P. Chkalov	25.5%
JSC Tupolev	90.8%
JSC Finance Leasing Company	58.0%
JSC Scientific and Production Corporation IRKUT	80.1%

Source: UAC

This was merely the start. The deal is complex, with many firms being swept under one umbrella. As one can see, UAC is not the sole shareholder in some of the firms, adding to the complexity.

As part of the firm's strategy, UAC has set the following goals for its civil aviation production:

- To dynamically increase sales of civil aircraft produced by UAC in the domestic market by manufacturing competitive products relative to foreign counterparts
- To gain parity positions in selected-for-positioning niches of the open foreign civil aircraft markets (regulated by free competition laws) by 2025.

The outcome of following these strategies is to achieve a 10% share in the world civil aviation market and more than a 50% share in the domestic market by 2025. Clearly as part of the outcome UAC is expected to improve its labor productivity to current western standards plus achieve an approximate 250% increase in revenues.

As these goals demonstrate, UAC can be expected to be a tough competitor. Recently the CEO of Aeroflot was "Advised" by now Prime Minister Putin to buy Russian aircraft if the airline expected state support. It was advice not to be ignored. The Russian government has made it plain that it will protect its domestic aerospace assets and use its clout to achieve this.

This is an important point, because China thinks and works the same way. The downstream impact of this is that the current WTO flap between Airbus and Boeing is largely a waste of time. It would be fair to say that we do not expect China and Russia to withhold state aid for their respective aerospace firms. Given China's financial muscle, neither Airbus nor Boeing can compete for funding from their own deep pocket supporters.

In the segment this study covers, UAC produces three aircraft.

Antonov An-148

This aircraft was first considered in the 1990's and by 2001 got its current name, having initially been known as the An-74. Three prototypes were started in 2002, with a goal to offer between 61 and 99 seats. By September 2004 the first prototype was completed in Kiev, Ukraine. In November 2004 the An-148 completed its first flight. In April 2005 the second prototype joined flight tests. Certification tests lasted two years. As the timeline suggests, time was one thing the firm had, otherwise it was resource constrained.

In February 2007 the An-148, its D-436-148 engines and AI-450-MS APU received the Certificate of the Aviation Register of Interstate Aviation Committee of Russia and the Ukraine State Aviation Administration. In July 2009 the first serial An-148 aircraft manufactured at VASO completed its maiden flight. Then in December 2009 the first An-148 started revenue passenger services with Rossiya Airlines. It took seven years to go from prototype to EIS.

Alarmingly, even after this long gestation period, the airplane has not been well received. Rossiya, the launch customer, has complained about reliability[13]. The airline reported that 235 malfunctions occurred during 1,725 flight hours between June to August in its first year. Maintenance and repair work took 2,139 hours, or about 89 days. This is an inauspicious start. Manifestly this level of productivity does not meet UAC's stated goals. We do not expect this project to have a a long production run unless UAC can seriously improve quality control.

To date eight Russian airlines and a handful of non-Russian firms have ordered the An-148. The table below lists the most current data on orders and deliveries. A recent crash of one of the test aircraft being demonstrated to the Myanmar Air Force led to six deaths. This is a setback for the program already beset with challenges.

Airline	Orders	Concentration		Deliveries
HESA(Iran)	50	20.1%	20%	
Atlant-Soyuz	30	12.0%	32%	
Polet	20	8.0%	40%	
India (non-scheduled airlines)	18	7.2%	47%	
Rossiya	15	6.0%	53%	6
Aerosvit Airlines	15	6.0%	59%	2
Aeroflot	11	4.4%	64%	
Moskovia Airlines	10	4.0%	68%	
Volga-Dnepr	10	4.0%	72%	
Venezuela	10	4.0%	76%	
Remainder	60	24.1%		
TOTAL	249	100.0%		8

As the table illustrates few of these airlines could easily afford to acquire western aircraft. The selection of the An-148 could therefore be seen as possibly their only option. This is not a strong foundation upon which to build the program. For example, Iran has no easy options. The country announced it has plans to build the An-148 in Iran.

But, UAC will no doubt use the An-148 project as a learning experience and ensure its staff and plant seriously picks up its game. Failure almost certainly will mean a potential closure of the program as the limited resources have other places to go and better serve UAC's goals. The regional aircraft market offers many options and anything that does not offer (at a minimum) reliable service is, to be blunt, toast. The program looks unstable.

SuperJet

The Sukhoi Superjet 100 (SSJ) is a modern, fly-by-wire regional jet in the 75- to 95-seat category. The SSJ is possibly a highly disruptive aircraft because it has features that make it stand out in a crowded field.

[13]http://en.rian.ru/russia/20100929/160768376.html

The SSJ is a state-of-the-art 100-seat regional jet. Designed, developed and built by Sukhoi Civil Aircraft Company (SCAC), in partnership with Alenia Aeronautica, Italy the SSJ is advanced, relatively low cost, comfortable and environmentally friendly. This is no old gussied up Soviet design.

In 2007 Alenia Aeronautica and Sukhoi Holding formed SuperJet International, a joint venture (51% Alenia Aeronautica and 49% Sukhoi Holding) based in Venice, Italy, which is responsible for marketing, sales and aircraft delivery outside Russia and the CIS as well as for worldwide logistic support for the SSJ.

The SSJ was designed specifically for a 100-seat segment and it offers a combination of regional jet efficiency with mainline jet capabilities. The aircraft currently consists of a 95/100 seat variant, but a 115/120 seat variant is being studied. In the industry tradition, there is always a stretch under consideration.

The SSJ offers a 3+2 configuration with generous personal space, spacious overhead bins to maximize storage for carry-on bags, and a relatively large cabin. In addition, the SSJ offers a low noise levels at cruise. The SSJ has as a high technology heritage; it is designed by Russia's premier builder of fighters. Its aerodynamics were tested in the advanced wind tunnel at Zhukovsky, outside Moscow which was also used by Boeing and Airbus for the 787 and A380 respectively.

What separates the SSJ from other Russian aircraft is extensive incorporation of modern Western technology: Thales for avionics (as used in A380 and 787); Messier-Dowty (landing gear); Honeywell (APU); Liebherr (flight control system); Hamilton Sundstrand, Intertechnique, Parker, Goodrich, and B/E Aerospace.

The SSJ uses SaM 146 engines produced by PowerJet, a joint venture between Snecma and Saturn. The engine has received its European Type Certificate (EASA) and the Russian Type Certificate (IAC AR). The SaM146 was designed and built specifically for the SSJ. It expected to offer a lower fuel consumption, which means reduced fuel costs, as well as lower emissions. Benefiting from Snecma's relationship[14] with GE on the CFM engines clearly is of great value to the SaM 146. An SSJ executive explained to us how the SaM 146 offered good economics because its engines have a bypass ratio of 4.43 and therefore does not have the drag of the next generation of bigger fans - the engine has competitive fuel burn and emissions with lower drag.

The SSJ cruises at a maximum of M0.81 at 40,000 feet. It requires a runway of 1,731 meters in the basic version and 2,052 meters for the long range version. The operating range for the basic version is 3,048km and 4,578km for the long range version.

The first SSJ prototype rolled out of SCAC's assembly shop at Komsomolsk-on Amur (Russia) in September 2007. The first flight was successfully accomplished on May 19, 2008. Based on other Russian civil aircraft programs, this rapid progress is unprecedented. The certification campaign used

[14] http://www.powerjet.aero/pjsite/web/guest/sam146

four prototypes for flight testing and two prototypes for static and fatigue trials. The four flying prototypes accumulated 2,530 flight hours in 1,060 flights. The aircraft met all its certification requirements.

In September 2010 one prototype transferred to Turin-Caselle Airport (Italy), to undergo certification tests for noise and high intensity radiated field tests. These tests were accomplished at Alenia Aeronautica's facilities in Turin-Caselle and represented a major step to obtain certification. In November 2010 the first SSJ production aircraft, to be delivered to Armavia, Started flying. There are currently 17 serial aircraft in production, 5 of which are in final assembly.

To date, the SSJ has 181 firm orders. The aircraft is ready for EIS and it is authorized to start commercial operation with its launch customers Aeroflot and Armavia early 2011. SuperJet International will provide after-sales service according to Western standards. Currently, the SSJ is the most important industrial aerospace program between the Russian Federation and the rest of the world in the field of the civil aviation.

Airline	Orders	Concentration	Options	
Russia Aeroflot	40	22%	15	28%
Indonesia Kartika Airlines	30	17%		
Bermuda Pearl Aircraft Corporation	30	17%	15	28%
Russia Avia Leasing (for UTAir)	24	13%		
Mexico Interjet	15	8%	5	9%
Thailand Orient Thai Airlines	12	7%	12	23%
Russia Finance Leasing Company	10	6%		
Russia Gazpromavia	10	6%		
United States Willis Lease Finance	6	3%	4	8%
Armenia Armavia	2	1%	2	4%
Russia Yakutia Airlines	2	1%		
Sub Total	181		53	
Non CIS		**19%**		**11%**

The SSJ's primary attractions include its offering lower operating costs that the Bombardier CRJ and Embraer E-Jets. Priced at $31.7m, the SSJ is clearly highly attractive and this is the reason the airplane is being so seriously. As we said above, it is potentially highly disruptive. Sukhoi says its tests show the SSJ has a 6-8% operating cost advantage over the E-190/195.

The following table lays out the SSJ's orders and concentration. Noteworthy is the fact that there are a number of Asian and Western customers for an aircraft that is just coming to the market. This has not happened for a Russian aircraft before. Indeed, based on the data in the table, just over 51% of the SSJ orders are from non-Russian sources. That alone should make observers sit up and take note. Of the options placed to date, non-Russian customers account for over 67%.

It would be fair to say this program is off to a great start. Its existence and success is surely a shock to the traditional firms with which it competes for business. Each sale it achieves is one Bombardier and Embraer lose. However, against that one must look at the size of the total market. That said, Russia's interest may be quite different from that of Alenia - while Alenia will want a profit soon, Russia's main goal may be to get its UAC interest stabilized in terms of production and employment. Profits may be important but are not necessary as a short term goal.

TU-334

The Tu-334 is designed to handle up to 102 passengers with range of up to 3,150 km. The Tu-334 program started in 1986 and was led by the famous Tupolev design studio. Like other Russian projects of that era, the disruption of the collapse of the Soviet Union was highly disruptive. The aircraft was supposed to fly in 1991, but was first displayed to the public in 1995. But the first flight only occurred in 1999.

The TU-334 was meant to replace the TU-134. While the TU-334 was designed to be based on the latest thinking in terms of aerodynamics, structures, avionics, time may have passed it by. The Tu-334 has a high degree of commonality with the layout of equipment and aircraft systems with larger Tu-204/Tu-214. Indeed the flight decks are the same.

However, the program seems stalled. Indications are that this program will be phased out[15] in favor of the An-148 and the SSJ. Iran has offered to build the airplane under license. It is not clear whether Iran will buy these rights for the reported $3 billion given the program's imminent demise.

[15] http://www.flightglobal.com/articles/2009/08/11/330688/russias-united-aircraft-reaches-maturity.html