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Shocks in the pipeline: oil prices have dealt a blow to airline optimism and forced a closer look at fuel efficiency Alamy Images

transfer of technology hindered the US offerings and believe US contractors will push for some

defence review in October, which saw the long-overdue Nimrod MRA4 reconnaissance aircraft programme scrapped as well as its fixed-wing aircraft carriers and their Harrier jets. Other cutbacks included the announcement that one of the two new aircraft carriers, currently under construction, would be mothballed or sold.

Consolidation stalks the defence sector while supply chain issues limit the civil side, write Mark Odell and John O'Doherty

he mood at this year's Paris Air Show will belie the gloom that the customers of the big aerospace and defence contractors are feeling.

Airlines are trying to put a brave face on the recent oil price rise that has all but wiped out heavy cost-cutting, efficiency improvements and capacity cuts put in place during the downturn.

With Brent crude, the Eurobenchmark, pushing pean towards \$120 per barrel, airline executives are contemplating a future pricing environment above the \$100 mark rather than a repeat of 2008, when the oil price touched \$140 before slumping below \$50 by the end of the year.

The rising optimism among airline executives late in 2010, prompted by signs of a nascent economic rebound, has dwindled in the face of the rising cost of fuel. The poor prospects for the industry were summed up this month at the annual meeting of the International Air Transport Association (Iata) in Singapore, when Giovanni Bisignani, head of the airline trade body, warned that there was "little buffer left against future shocks"

Iata, which has 230 members, has more than halved the collective net profit outlook for the industry for 2011 from \$8.6bn (£5.3bn) to \$4bn. This compares with a profit of \$18bn in 2010, one of the few profitable years for the global airlines industry in the past decade

The picture is similar on the defence side. Customers are under pressure as western governments, including the US, take an axe to defence spending in an attempt to balance budgets burdened by bail-outs during the financial crisis.

But while defence executives are facing up to a some tough decisions from customer governments on some of the big weapons programmes, many of their



On FT.com/corporateaviation Hawker Beechcraft

High Flying column Themes, news and views from An interview with Bill Boisture, chief executive of a company the FT's Aircraft Columnist, Rohit Jaggi, in our guide to with a long history in aviation.

figure suspects it will go for a Házy, a pioneer of aircraft leas-

and 50 per cent over the next new aircraft. Steven Udvar three years, the supply chain, which suffered badly during the ing who runs Air Lease Corpora- recession, could struggle to keep tion, has worked with Boeing up. "The aerospace supply chain for the past two-and-a-half years was basically decimated by the on defining the next-generation economic downturn," says

allocation of development costs. Yet there was also bad news for Airbus parent EADS. It lost ward this year. Boeing won the KC-X, a \$35bn contract to

out in the other large defence relaxation as they face falling project that finally moved for- spending at home.

The budgetary squeeze was painfully obvious in the UK's

counterparts in civil aerospace are quietly toasting the fact that the big two - Airbus, a subsidiary of EADS, and Boeing - continued to deliver aircraft at near-record rates during the downturn. The combined total last year was 972.

Regional and business jet makers, such as Canada's Bombardier and Brazil's Embraer. recorded another year of falling or flat output and order books remain under pressure. But they too are more positive about the future as air travel, which has grown on average 5 per cent a year since 1980, is expected to continue to outstrip global economic growth over the next 20 years.

Damien Lasou, head of consul-Accenture's aerospace tancv and defence group, says it is the forecasts of strong traffic growth and not short-term airline profitability that the aircraft makers focus on. "The



underlying driver of the industry is the traffic. More traffic requires more aircraft."

of its 747-8 passenger jet and

freighter, as well as the wide-

body 787. One of the biggest

Airbus's decision to launch the Boeing will underline the bull-A320 Neo, a re-engined version ishness of the big two commerof its best-selling narrow-body cial jet makers at Le Bourget family. The US group will come under with its biggest yet commercial aircraft presence at the show, heavy scrutiny after sending out including international debuts

mixed signals about whether to upgrade its existing 737 or go for an all-new aircraft. industry One influential

questions in the industry is

what Boeing will do to counter

narrow-body. "I think the culture would point you towards an all-new design that would follow the Neo by a number of years; my guess is at least three to four minimum," he says.

Airbus, as it usually does in what is in effect its own backvard, is expected to beat Boeing in the traditional race for show orders, not least with a raft of new Neo customers to take it past its target of 500 commitments by the show.

The big two, with bulging order books, are stepping up

production rates across their most popular narrow and widebody lines over the coming The rising output is vears. expected to result in commercial iet aircraft deliveries surpassing the 1,000 unit milestone for the first time this year, according to AlixPartners, the consultancy.

This ramp-up does not come without risk, however. With production set to rise by between 30

Thiery Duvette of AlixPartners. "From all indications, that supply chain is not at all prepared for [the] steep commercial ramp-up curve that lies ahead, and production constraints are a very real possibility."

In contrast to the commercial sector, the outlook for defence prime contractors is less clear. The sense of relief at resolutions to a number of long-delayed projects is tainted by a growing sense of unease at further defence cuts.

This year the future of the A400M, a military transport aircraft, was secured when Airbus and the seven European countries funding the programme finally agreed a deal to allow it to move into production. The original €20bn programme is €11bn over budget and four years late after constant wrangling between Airbus and the launch nations specifications and over

replace the ageing fleet of US air-to-air refuelling tankers. The deal, which with follow-up orders could be worth as much as \$100bn, pitted EADS against Boeing for a decade, with the contract at one point being awarded to the European group. However a subsequent appeal reopened the contest, and in February, the Pentagon announced Boeing as winner.

Disconsolate Europeans may have grumbled under their breath about protectionism, but US concern for safeguarding defence expertise at home may not always play in the country's favour. This was made evident in the \$11bn Indian tender for 126 jet fighters. Both US bids -Boeing's F-18 Super Hornet and Lockheed Martin's F-16 - lost out as India whittled down its choices to two: Dassault's Rafale and the Eurofighter Typhoon.

Defence experts say US restrictions on the use and

The US is also set to cut its defence budget, the world's largest at \$690bn last year.

As part of cuts amounting to \$78bn over five years, the Pentagon announced changes to the F-35, a high-tech fighter jet in development. The delayed vertical take-off version is now on "probation", and if technical problems are not resolved on this version within two years, the programme will be cancelled.

Additional reporting bu Jeremy Lemer.

New entrants challenge big two in short-haul market

Narrowbody jets

Boeing-Airbus duopoly faces up to competition in the sector. Mark Odell and Hal Weitzman report

The battle for position in the largest part of the civil airliner market – the narrowbody segment - is expected to hold much of the attention at this year's show at Le Bourget.

The duopoly enjoyed by Airbus and Boeing in large commercial jets since the late 1990s is coming under increasing pressure from new entrants and established aircraft makers targeting the shorthaul market between 100 and 200 seats.

The segment is dominated by Boeing's 737 and the Airbus A320 family. Harry Nourse, an analyst at HSBC, says the segment is "in a state of near-perfect equilibrium" as the backlog and production rates of the rival products are almost identical.

The two types account for about half of all commercial jets flying today. The 737 has a higher installed base of close to 60 per cent, according to data from the Ascend aerospace consultancy, largely due to its longer history. The first 737 entered service in 1967, while the A320, accounting for 36 per cent of narrowbodies today, number of engineers committed to

first flew commercially in 1988. The attraction of the narrowbody market to other manufacturers, such as Canada's Bombardier and China's Comac, is clear. With airline traffic forecast to grow at more than 4 per cent annually over the next 20 years, the segment is expected to see demand for close to 25,000 new aircraft, or 70 per cent of total deliveries. In value terms, this represents roughly half of the \$4,000bn worth of large commercial jets the big two aircraft makers are forecasting for delivery to 2030.

So after decades of relative stability the two incumbents in the market, so long reliant on the stable cash flows from their hugely popular narrowbody offerings, are having to think again. The pressure is not just coming from the threat of new entrants taking market share.

For years many in the industry expected both manufacturers to come up with all-new aircraft designs for the workhorses of the global airline industry. But Airbus and Boeing have had strong reminders recently of the risks of new aircraft programmes, encountering huge problems with the A380 and 787 respectively.

Even before cost overruns, a new aircraft programme comes with a price tag above \$10bn and consumes huge engineering resources. Both Airbus and Boeing already have a large

widebody projects. Airbus moved first, at the end of last year, with its decision to offer an upgraded version of the A320, featuring a more efficient engine along with structural modifications to the wings and fuselage, and a promise to cut fuel-burn by 15 per cent. The manufacturer says the upgrade will cost €1bn.

The so-called A320 New Engine Option, or Neo for short, has already attracted a flurry of interest from airlines, securing just over 330 orders and commitments. The early selection on more than two-thirds of those aircraft of one of the two engines available – Pratt & Whitney's revolutionary PW1100G - has allowed Airbus to bring forward the entry into service of the Neo by six months to October 2015. Airbus is expected to use the Paris air show, which executives at both the jet maker and its parent, EADS, regard as their home turf, to announce a number of further commitments.

Analysts will be watching closely to see how many customers sign up to the rival engine, the Leap-X built by CFM, a joint venture between France's Safran and General Electric of the US, and based on existing engine technology. Most analysts suspect CFM will have trouble matching Pratt's engine in fuel efficiency.

At the time of the launch, Airbus predicted it would have more than 500 commitments for the Neo by Paris and there is every expectation that number will be easily surpassed by the end of the show.

Boeing, in contrast, has sent out mixed signals since Airbus took the plunge and its response will come under intense scrutiny again in Paris.

While the US aircraft-maker had initially indicated very strongly that it was more likely to opt for a brand new jet rather than to re-engine the 737, it has in recent months emphasised that re-engining the popular aircraft remains a serious possibility.

Earlier in the year there were expectations that Boeing might announce its decision at Paris. But that has now been ruled that out. Nicole Piasecki, vice-president of business development and strategic integration at Boeing Commercial Airplanes, says the company might wait until next year.

Some analysts say Boeing could wait even longer. "The Neo is getting

traction but Boeing still has an order book for the 737 equivalent to two to three years of production – so it is not seeing any impact of the Neo on revenue. That means there is no burning platform from which they have to make a decision," says Damien Lasou, head of Accenture's aerospace and defence group.

The two biggest 737 customers, Southwest Airlines of the US and Ireland's Ryanair, have both voiced concern about a lack of response from Boeing, but Mr Lasou does not believe either would switch to Airbus. "I don't think that is a danger for Boeing at this stage," he says.

But whatever Airbus and Boeing do to try to maintain their position in the narrowbody segment, the days of the duopoly are numbered.

Rivals and some analysts have suggested that the relatively slow pace of orders for Bombardier's C-series - a family of aircraft with a capacity of between 110 and 145 seats - suggests it will struggle to make an impact.

But Mr Nourse at HSBC argues that the success of the 787 and the Airbus A350 has "abnormally inflated" expectations of a successful launch.

Bombardier's 103 firm orders and 103 options for the C-Series more than two years before first delivery "seem perfectly respectable to us in light of history", Mr Nourse wrote in a recent note on the narrowbody market.

There is also another way the threat to the established duopoly could develop. The signing of a strategic agreement between China's Comac and Bombardier in March this year has raised the possibility that the two could combine in the future to present Airbus and Boeing with an even more formidable competitor.

Regional jets, Page 3



On target: Airbus predicted it would have more than 500 commitments for the A320 Neo by the end of the Paris show

Sitting cocooned aloft in the lap of luxury



Flying high: Lufthansa's first class beds on the A380

Premium travel

Airlines have invested in better seating and beds, writes **Tom Otley**

f there was ever a golden age of travel this is surely it. There are unrivalled frequencies to a breathtaking range of destinations, and, for those in the front of the aircraft (or upstairs on the A380), quite astonishing levels of comfort.

In the face of economic uncertainty and the high price of oil, airlines have continued to invest in their onboard product to attract premium travellers. Global premium air travel jumped 6.1 per cent in the first quarter of 2011, according to the International Air Transport Association, faster even than the overall 5.9 per cent increase in traffic, and airlines are responding by increasing competition. The improvement in the seating offered to business and firstclass passengers means that today, whether in Asia, Europe, the Middle East or the Americas, airlines both old and new are offering the most comfortable and luxurious seating yet seen.

Cathay Pacific presents a good example. Strategically placed to take advantage of the huge existing and potential demand from China, it is quickly increasing its fleet of aircraft while at the same time ensuring that the seating it offers its business and first-class passengers is the best in the world. The carrier recently announced "next-generation" busi-

ness-class seats only four years because, viewed from above, the Gulf carriers - particularly Emirsince its last reinvention. In part, this is recognition that these seats had not proved popular. The airline listened to feedback, and is now quickly ripping out the seats and putting in new ones.

Cathay's competitor, Singapore Airlines, meanwhile introduced new business and first-class seating, and in addition has increased the number of business-class seats on its new-delivery Superjumbo A380s by 13 per cent. Now the whole upper deck of the A380 will be premium seating, as will that on the just-delivered Korean Air version of the Superjumbo.

Korean Air has said it is targeting 50 per cent of passenger sales from premium classes (business and first) by 2019. Asiana has fully flat beds in business in a staggered layout allowing all passengers to have direct access to the aisle.

For those who have flown only occasionally in business class, the differences between these seats and services may seem small surely fliers just book the airline that flies directly from A to B? In some sense, yes, although even on those routes there is usually competition.

The importance of seating is twofold, however. All airlines face the problem of making the most of the "real estate" of the aircraft how many seats they can fit into a small space while giving as much room as possible to the passenger, yet at the same time not pricing themselves out of the market. British Airways in its ClubWorld seating adopted a backward and forward facing arrangement (called ying yang), while Virgin Atlantic went for herringbone, named

seats look just like that. This latter design has been adopted by airlines as diverse as Air Canada, Air New Zealand and Cathay Pacific, although there are differences as to whether the seats face the windows or look away from them (the former is now preferred in the new

designs). The lead set by BA and Virgin for fully flat beds on lucrative and competitive - North Atlantic routes was one American carriers struggled to match for many years, but no longer. Continental now has fully flat seating in business on all its B777 and B757 narrowbody aircraft, while Delta has

The lead set by BA and Virgin for fully flat beds was one that American carriers struggled to match for many years

completed its full-flat businessclass seating on all its Heathrow flights.

United Airlines has completed its new business and first-class seating on the Boeing 767 and 747, with the 777s to be finished by the end of 2011. In Europe, Swiss International Air Lines has an upgraded cabin, featuring a 2mlong flatbed, available on all its long-haul routes from July, and Lufthansa has introduced not only a new first-class seat, but a separate bed alongside it.

Along with price, the seating Tom allows for important marketing Business Traveller differentiation. The advent of the www.businesstraveller.com

ates, Etihad and Qatar Airways has tempted many fliers to use their services and take advantage of their huge route networks from their home hubs of Dubai, Abu Dhabi and Doha respectively. Having new fleets of aircraft, and new impressive seating on board helps persuade premium fliers that the extra time taken to get to their destination will not be time wasted, or uncomfortable. Throw in the number of flight frequencies, and it becomes a compelling option. The improvement has also put

new life into first class. British Airways is completing its rollout of its First product by the end of the year, and airlines such as Lufthansa and Air France are continuing to offer first class on selected routes. For the Gulf carriers - with the notable exception of Qatar Airways, which says it will not introduce a new first-class product, though it continues to offer it on certain routes such as London–Doha – Emirates and Etihad have continued to invest in first-class suites, as have Asian carriers such as Cathay Pacific, Singapore Airlines and Korean Air.

Japanese carrier ANA has a suite product in first class with a 23-in touch screen LCD TV, which ANA says is the largest in its class. Washrooms in the premium cabins will also feature warm-water bidet-toilets, with ANA claiming to be the first airline to install such facilities

is Otley editor of magazine

deal to set up a design house in

the UK to "navalise" the Gripen

for carrier operations, without

explicitly identifying which

countries he is targeting – both

India and Brazil are building up

But internationalisation will

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Swedish group has acquisitions in its sights

of

Saab The Gripen is at the heart of efforts to internationalise, says **Mark Odell**

Håkan Buskhe, chief executive of Saab, admits he is still "on a learning curve" after taking over at the Swedish aerospace and defence group last year.

The 47-year-old may lack experience in the industry after a tise when it comes to the Nord-

immediately was the size of ently since 1990 of the troubled tionally for Saab has been Saab's engineering base and the car manufacturer that shares its level of innovation at a comname pany dwarved by most of its Mr Buskhe has picked up his predecessor's strategy peers – last year it reported

increasingly weaning the comsales of SKr24.4bn (\$3.9bn), a slight drop on 2009. This company off its reliance on Swepares with 2010 revenues of den's armed forces. €4.19bn (\$5.99bn) for French During the Cold War, Sweden rival Dassault Aviation.

maintained a policy of fierce military independence by sourcing almost all of its weapons systems from domestic supplidevelopment, which is 20 per ers, chiefly Saab.

The struggle to establish itself backbone of engineering exper- internationally, while relying on Of engineering a high-cost Swedish base, has

through its Gripen fighter. The aircraft, which first entered service with the Swedish air force in 1993, has been sold to the Czech Republic, Hungary, South Africa and recently Thailand.

But those "wins" have all been relatively small deals, with the bigger competitions still eluding Saab. The most recent

'We are the backbone

company's key advantages in international markets.

He says the Gripen is a match for the Typhoon and Rafale when both performance and price are taken into account and he does not rule out India re-opening the competition once it has digested submissions not come through the Gripen

from the rejected bidders on its alone. shortlist. "Let's see about India – there been down-selections have

Mr Buskhe is looking to use the company's balance sheet, with net cash of about \$600m, to before that have been changed," make acquisitons.

their naval air forces.

He concedes they will be rela-"They [the Indian govern- tively modest and must either ment] still need to evaluate enhance the company's product

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career spanning areas as diverse as brewing and logistics, but as an engineering graduate and a weapons technician during his military service in the 1980s, he at least had some grounding in Saab's area of expertise.

Nevertheless, he sought to get to grips with his new charge after leaving his post as regional head for Scandinavia for Eon, the German utility, by shadowing his predecessor, Ake Svensson, for a month before taking the helm at Saab at the start of September last year.

What struck Mr Buskhe

ics with over 7,000 engineering graduates in Sweden alone," he nesses.

Mr Buskhe is keen to stress the level of investment in R&D as he seeks to carve out a niche for the company, which employs 12,500, in international markets. "Saab is a rather unique Swedish company given that we have nearly 75 per cent of our employees in Sweden but generate 70 per cent of our sales from

"What is not maybe visible to

the public or investors is the

key investment in research and

cent of turnover. We are the

abroad," he says. The company, which derives almost all of its revenues from defence, has operated independ-

savs

forced the company to take the axe to its unprofitable busi-

Mr Buskhe put his own stamp on that strategy by identifying a further SKr500m of cost-savings in his first few months in charge to add to the SKr1bn in cuts that Mr Svensson had already targeted.

And Mr Buskhe was quick to grasp the nettle, or "delicate issue" in his words, of cutting 600 jobs when he had to oversee the closure of two Swedish factories

The most visible push interna-

expertise when it comes to the Nordics

setback was the decision by the Indian government to reject Saab, along with the two US bids and a Russian one, narrowing the contest down to France's Dassault Rafale and the multinational Eurofighter Typhoon.

Saab had promoted the Gripen as the "independent" choice, picking up on Sweden's perceived neutral status in global politics and a theme that Mr Buskhe refers to as one of the

these two products [Typhoon and Rafale] and they need to be competitively priced."

he says.

Even if India remains closed for Saab. Mr Buskhe insists there are other potential sales in the offing after the Swedish parliament recently agreed to continue to finance development of the weapon system up to 2035. The other big fighter competition where he believes Saab has

a good chance is Brazil. And even though the new government has delayed that process, Mr Buskhe is looking beyond that opportunity, with a recent air show this week.

offering or "increase our presence in key markets", with the US and UK the most likely targets. "We will take our time," he savs.

Meanwhile, he hopes to find more opportunities for Saab's "homegrown" products, ranging from ground-to-air missiles to the Erieye airborne early warnings system in use by the Mexican, Greek, Brazilian and Pakistan air forces, as well as that of Sweden.

Some of that work wil start for Mr Buskhe at his first Paris



the B787 Dreamliner and the B747-8, is from Avio. The reason is real commitment, constant over time, that has turned Avio into a leader in the aerospace, marine and industrial sectors. Partner in the most important international programmes, Avio is a point of reference for R&D, design, production and technical assistance. Since 1908. www.aviogroup.com



Where old aircraft go for a course in recycling

Spare parts Scrap is attracting

hedge funds and private equity, says Jeremy Lemer

At AJ Walter Aviation's new engine division just north of Cardiff, Wales, Steve Williams, director of technical purchasing, is excitedly awaiting a delivery of a batch of five aircraft.

When they arrive over the next few months, the Boeing 737 classics will be The dismantled. CFM engines will be removed and leased or sold to airlines, or chopped into parts and traded to maintenance and repair organisations around the world.

The airframes will be passed to another AJW unit for reuse, or, more likely, disassembly. Valuable parts such as landing gear and avionics will go into AJW's warehouses, while scrap metal will be sold for recycling

Mr Williams hopes the jets will be the first of many. AJW established the engine business in January but has ambitious growth targets. Within three years it expects the unit to have revenues of \$200m and represent 30 per cent of the part management com pany's sales.

While much attention has

demand for new aircraft amid the wobbly global recovery, a small band of financial investors and industry experts have chosen to specialise at the other end of the cycle squeezing value from old

aircraft. AJW is the latest of a handful of companies that have entered the "part-out" segment, drawing attention from private equity and hedge funds. Since the global recession began, industry veterans have estab-2011.

lished AerFin in the UK and AerSale in the US. In early 2010, for example, AerSale raised \$250m in equity from Green Equity Investors V, part of Leonard Green & Partners, and laid out plans to buy more than

the next five years. The Aircraft Fleet Recycling Association, a nonprofit organisation, predicts that over the next 20 years up to 12,000 aircraft, or 600 a year, will need to be dismantled as the global fleet ages, oil prices rise and

demand for air travel increases. Experts estimate that about 70 per cent of an aircraft can be recovered. At that level, older fuel guzzling aircraft are worth more as parts and scrap than they are intact and flying passengers around the

world Behind the new money lies a shrewd assessment about the state of the avia-

focused on the growing tion industry and the market for used parts. Executives are betting that they can buy relatively cheap aircraft and profit as airlines fly more, and demand for spares recovers.

Indeed, aircraft values remain depressed after the multi-year recession. Mean-

while, the aftermarket for parts is finally seeing growth after a prolonged slump. RBC Capital expects aftermarket revenues at leading manufacturers to grow up to 12 per cent in

At the same time, existing outfits have been snapped up by companies with very different goals. In 2006 General Electric's aircraft-leasing business purchased the Memphis Group moved into leasing.

Older fuel-guzzling aircraft are worth more as parts and scrap than they are intact and flying

while AerCap, the listed leasing group, bought Aero-Turbine.

For such leasing compaedge of every nut and bolt nies, investments in "parton an aircraft in order to ing out" aircraft represent a exploit differences between defensive move, a way to the cost of an aircraft and hedge against a fall in its value as spare parts. demand for older planes. If no one wants to rent their by Aeroxchange and partsassets, they can always base.com give airlines turn them into valuable almost perfect visibility into the availability of spare parts.

Kevin Michaels, of Aero parts, but prices can change



Awaiting reincarnation: old airliners in Arizona

Strategy, an aviation conrapidly and long-term presultancy, notes that the dictions that must factor in leasing and parts trading fuel prices and new aircraft businesses have gradually performance are tough. merged. Lessors have acquired part-out compano value and then the next nies while part-out groups day, because there is just such as GA Telesis have

rently has a pipeline that

extends out to 2017, says

Abdol Moabery, founder

Whatever the motivation

for entering the teardown

sector, to be successful

executives require knowl-

Vast databases provided

and chief executive.

one in Europe, the price can multiply by 10. There are no For GA Telesis, the shift rules for this," says Martin Fraissignes, AFRA's directo purchase aircraft that tor and general manager of are leased to airlines was driven by a need to secure a Chateauroux Air Centre. steady supply of parts for The work of dismantling the future. GA Telesis cur-

the aircraft is mostly done by engineering specialists, such as Avocet in Florida and Air Salvage International in the UK. Part-out groups often give the work to airline repair shops in order to build relationships with potential clients.

"One day a part can have

Certain long-term trends have also combined to boost the sector.

In particular a decadelong squeeze on airline profits has made leading carriers focus on driving down the cost of maintenance and repairs by using secondhand rather than new spare parts.

\$1bn of aviation assets over

Emerging producers shake up the old order

Regional jets

New entrants herald an era of increased competition in the sector, writes **Kevin Done**

merging manufacturers in Russia, China and Japan are shaking the established order among producers in the main segments of the global commercial aerospace industry.

The initial attack is being launched in the regional jet sector. Life is set to become a lot more complicated for Embraer of Brazil and Canada's Bombardier during the next few years.

Russia and China also have larger aircraft under development that will take them into direct competition with Airbus and Boeing in the market for single-aisle jets with a capacity of about 150 seats and above.

It will be well into the second half of the decade before these products enter commercial service, but in the regional jet market the threat of increased competition is already a reality.

Not surprisingly, the ambitious development programmes launched in Russia, China and Japan have fallen well behind their unrealistic initial schedules. Gradually the delays are being overcome, however, and a key milestone was finally reached this year with the entry into commercial service of the Sukhoi Superjet 100.

The first Superjet 100 started flying with Armavia on the route between Yerevan and Moscow in April,

Within 12 months China's

ARJ21 is also scheduled to enter service, and the picture should be complete by late 2013 or 2014, when the Mitsubishi Regional Jet (MRJ) from Japan takes up the commercial challenge.

It will still take years for the new producers to build a truly global presence with the sales and marketing and maintenance support networks necessary to present a credible threat to Embraer and Bombardier in their well-established markets, but the game has been joined in earnest.

The Sukhoi Superjet 100 is the first new civil aircraft programme in post-Soviet Russia and the ARJ21 and MRJ represent similarly momentous stages in the development of the aerospace industries in China and Japan.

Their arrival launches a new era of competitive instability and an eventual shake-out in the regional jet sector appears inevitable.

It has happened before. During the past 10 to 15 years several other commercial jet makers of aircraft up to 100 seats fell by the wayside including Fokker, British Aerospace and Fairchild Dornier, as Embraer and Bombardier established themselves as the dominant forces.

"Now we see again new entrants," says Paulo Cesar de Souza e Silva, Embraer president of commercial aviation. I believe five in this segment is too many.'

The existing big two forces are determined they are not going to be swept aside by the new challengers despite voicing fears about the level of government funding available to their competitors.

Canada's Bombardier, the pio-



Reflecting increased rivalry in the sector: the Sukhoi Superjet 100, first of the incomers into service

neer of regional jets, has Lufthansa and Republic Airdecided that its future lies in moving upmarket in terms of size and is already well advanced with the development of its CSeries jets, which are being optimised at 110-130 seats.

The CSeries takes the group for the first time into the lower end of the market dominated by Boeing and Airbus, but it also lifts it above the segments of

70-120 seats, where Embraer has become the leading force, and where Russia, China and Japan are launching their initial assaults.

It has proved to be a tough marketing battle for Bombardier, as it has fought for launch sales in this new niche ahead of the planned commercial entry into service of the CSeries in 2013-2014, but it is slowly building the order book with 103 firm orders in place from five customers led by Germany's

ways from the US.

Embraer, the current market leader in regional jets with its range of 70-120 seat EJets, is also being forced by all the competitive activity to reconsider its own strategic options. Its first EJet was delivered in 2004, and

Time is starting to press on Embraer as it considers how best to protect its dominance

Mr Cesar says: "We must be sure this is competitive to the new entrants.

The Brazilian group is also considering whether it must bite the bullet and move up in size, but it is mindful of the huge risks of taking such a step, and it is wary of what plans

Airbus and Boeing are developing for their new generation single-aisle jets.

"We are searching through the alternatives, but we still have to know more about the competition," says Mr Cesar.

"We are talking a lot to the market place and to the engine manufacturers. We are looking at larger aircraft, yes, but we have to understand what is being offered by the others. We are still missing information."

Time is starting to press on Embraer, however, as it considers how best to protect its current dominance, and Mr Cesar says: "We understand we must make a decision by the end of the year or in the next 12 months."

Embraer and Bombardier forecast significant growth in sales during the next 20 years both to meet higher demand and to replace existing older aircraft.

The two groups define the mar- mercial aircraft at Bombardier ket segments slightly differently in line with their own product offerings, but a similar picture emerges.

"Our 20-year market outlook suggests order prospects are strong at the top end of the 30to 120-seat aircraft capacity segment," says Mr Cesar. It forecasts that world air transport demand will be almost 2.7 times greater in 2029 than in 2009.

Embraer forecasts a requirement for 6,875 new jets in the 30 to 120-seat segment during the next 20 years with a total market value estimated about \$200bn. Of the total the greater share or about 3,980 jets will be delivered in the second half of the period between 2020 and 2029 and of the total 3,885 will be accounted for by the larger aircraft in the 90 to 120-seat segment

Gary Scott, president of com-

AFP/Getty Images

Aerospace, also believes the long-term factors driving growth in regional jets are solid in spite of the threat posed by volatile and high oil prices.

The Canadian manufacturer forecasts 13,100 deliveries in the 20- to 149-seat capacity segments in the period 2011-2030, with the world fleet growing from 11,000 to 17,400. The main markets will be North America, China and Europe.

In the more immediate future, however, both regional jet makers are still fighting to overcome the impact of recession on their operations.

Pierre Beaudoin, Bombardier chief executive, told investors recently that its commercial aircraft operations had been "slower to recover" than its business jet division, but it was seeing "an improved level of interest from customers"



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Up in the air: Chinese opposition sparked a new focus on the EU emissions scheme

Europe shows little sign of wavering over green flights

Emissions

EU is adamant about gas trading system, writes **Pilita Clark**

hat a difference a couple of months can make. Not that long ago, most of world's leading airlines the seemed to be resigned to the fact that from January next year, they would be brought into the European Union's emissions trading scheme, the first large-scale greenhouse gas trading programme.

A long-running legal challenge launched by US airlines seemed to be meandering nowhere.

The aviation industry groups that had lobbied heartily against the 2008 European Parliament vote approving the move were largely silent.

So were others in the industry, such as Airbus, the Toulouse-based aircraft maker, and national governments.

But last month it emerged that Chinese aviation authorities were not happy about the prospect of a foreign country forcing their airlines to pay for their pollution.

The China Air Transport Association openly declared the move "violates international aviation convention and intrudes into China's national sovereignty'

reports quoting News unnamed officials suggested Alamy Images

"countermeasures" against European airlines or other businesses

Suddenly, the European industry rediscovered its voice.

By late May, Airbus and the Association of European Airlines had penned a sharply worded joint letter to Connie Hedegaard, the EU climate commissioner, warning that Brussels faced a trade war with countries as large as China and the US.

"It is madness to risk retaliation," said Airbus chief executive Tom Enders and Virgin Atlantic's Steve Ridgway, holder of the AEA chairmanship.

News of their letter came as the world's leading airline executives descended on Singapore for the International Air Transport Association's annual general meeting.

Iata director-general Giovanni Bisignani told reporters the risk of retaliation "for a Europe that is in survival mode would be the kiss of death"

Separately, a July hearing date was set down in the European Court of Justice for the US airlines' case against the inclusion of aviation in the emissions trading scheme.

Ms Hedegaard, who is leading what amounts to Europe's most ambitious move yet to force the world to comply with European climate rules, found herself confronting a concerted bout of political pressure.

Her response was robust. 'This is a piece of legislation done under the former commission with the unanimous sup-

"Everyone knew what they were doing.' The emissions trading scheme already included thousands of plants in industries ranging

and a very, very broad majority

she told the FT in an interview.

in the European parliament,

from power generation to iron and steel, glass and cement, she said. Why should aviation be exempt? The EU had been arguing for

years, moreover, that there should be international rules to regulate aviation emissions. The idea was being discussed

The EU argued for years that there should be international rules to regulate aviation emissions

in 1997 when the Kyoto Protocol was agreed

Under this agreement, 37 industrialised countries and the European Community agreed to cut their combined emissions to 5 per cent below 1990 levels by 2008-2012.

Aviation was excluded from the deal and a UN agency, the International Civil Aviation and Organization, was given responsibility for coming up with an agreement.

But ICAO failed to come up with a global, binding pact to European Commission presisignificantly cut the industry's fast-growing emissions, raising sounding robust at a June 8 political pressure to have avia-

China might take unspecified port of the 27 member states tion covered by the EU's emissions trading scheme.

As Ms Hedegaard puts it: "For many years we tried to get international regulation, and at a certain point the EU said, 'We cannot in the long run exempt a whole global sector like aviation'." It was also decided it would be unfair if the ETS were only to apply to European airlines, so it was ruled that all flights coming into and leaving Europe would be covered.

Airlines will initially get 85 per cent of their emission rights free. But if their emissions exceed the amount covered by their free allowances, they will have to buy more – either from other regulated companies, through the carbon markets or from government auctions. Some studies have suggested the extra costs of the scheme will amount to as much as €1.1bn (\$1.6bn) in the first year alone.

Ms Hedegaard insists it would set a bad precedent for the EU if it were to back down to countries such as China.

However, there is a clause in the ETS that exempts airlines from outside Europe if they are from countries with so-called "equivalent measures" to cap emissions.

China has recently announced it is keen to make such moves Brussels is studying whether it might allow an exemption.

But Brussels has been showing little sign of wavering, with dent, José Manuel Barroso news conference.

Going through the hoops for a cleaner form of propulsion

Biofuels

within that standard. and at the time of writing, Unfortunately for full ASTM committee

Stringent tests are neeeded before regular flights can begin, says Pilita Člark

It is more than three years since Virgin Atlantic became the first commercial airline to operate a flight powered partly by biofuel.

The Heathrow to Amsterdam flight, which used a blend of fuel derived from coconut and babassu nut oil, was a test flight like all those that followed on other airlines.

This year Lufthansa was supposed to take the industry's efforts a large step further. The German airline announced in November that it would become the first in the world to start operating regular commercial biofuel flights with paying passengers in April.

It planned to fly an Airbus jet between Hamburg and Frankfurt using biofuel from Neste Oil, a Finnish group that specialises in green fuels. It had to suspend its

plans when ASTM International, a Pennsylvaniabased body whose regulatory, technical and industry members jointly develop standards for new products, failed to approve the required aviation biofuel standard.

Until now it has been virtually impossible to use biofuels on regular flights with paying passengers because airlines must use standard fuels with very precise properties, as defined by fuel specifications such as ASTM D1655.

This is the standard specification for aviation turbine fuels and covers properties such as combustion, corrosion and fluidity in cold weather.

Any airline using a fuel that does not meet the specification risks having its aircraft operators' certificate revoked.

Until recently only fuels derived from fossil sources were specifically included in ASTM D1655.

But ASTM International has since developed a newer specification, ASTM D7566, and had been working on approving biofuels produced by "hydroprocessing" plant oils, or treating them with hydro- approved gen, that could be included Lufthansa's Mr Buse says,

approval did not materialise after problems emerged in results ASTM International

had been studying. According to Joachim ply chain is job number Buse, Lufthansa's vice-president for aviation biofuel, the tests revealed "filter clogging at a temperature

of minus 10 degrees Celsius, aircraft tanks." which of course is totally unacceptable for aviation". nobody really wants to fly

with that product," he says. A new set of tests had to be done but testing facili- place after the ASTM ties were not available at short notice. Lufthansa itself ended up paying for the process say they expect some tests to help speed

things up, he says. tests eventually The revealed the fuel had been

contaminated, he says. "The parties in ASTM insisted on a redistillation of the contaminated batch to see whether the re-distil-



'There is no doubt that nobody really wants to fly with that product'

Lufthansa's vice-president for aviation biofuel

lated fuel would behave as expected, and it did so," he says.

In other words, it was a ment in terms of the uptake Richard Altman, executive Aviation Alternative Fuels lines, government agencies, that has been pushing for

"There wasn't anything endemic in the chemistry,' he says, adding that the batch did not come from Neste Oil.

doubted the delay would end up being significant.

they have in terms of maintenance on the aircraft and how they are transported to the aircraft.

The relevant ASTM subcommittee has the

Lufthansa, the expected approval was expected within days.

"The message from this some of the biofuel test incident is really that quality assurance and quality treatment in the entire sup-

> "We're happy this failure of the product was identified before it entered the

clear exactly when the "There is no doubt that Frankfurt-Hamburg flights will start, because it depends on several official steps that have to take

> Others closely involved in to see the flights start by August, and the event shows the system has

> "The one thing this industry is focused on is safety,

safety, safety," says Paul Nash, head of new energies at Airbus, the European aircraft maker whose A321 jet

is to be used in the Lufthansa flights. Both Airbus and its US rival Boeing have been focused heavily on biofuels for some time.

Virgin Atlantic's first flight used a Boeing 747 jumbo jet. Airbus has been involved in similar test flights. But it has shifted its strategy from demonstration flights to trying to act as a catalyst to speed up the

Joachim Buse commercialisation of biofuel. "We're trying to bring together the farming com-

munity, the refining community, airports, distribution network and also the airlines to make a commit-

"bad batch" of fuel, says of fuel," says Mr Nash. "Because we realise if director of the Commercial nothing is done from a global aviation perspective Initiative, a coalition of air- then we're looking at seven to 10 years away before we engine and aircraft makers get biofuels for aviation, whatever we do in terms of

biofuels to be approved. approvals." The regular Lufthansa passenger biofuel flights are designed to be an important part of this process, he says. For the first time they will

Mr Altman says he show what happens when biofuels are put into longterm storage; what impact

"It's kind of like your moon launching got put off a few days. It's not a fundamental issue," he says.

But first, there is the now small matter of getting the flights off the ground in the fuel. first place.

one," Mr Buse says.

Mr Buse says it is still not

approval is finalised.

worked as it should.

Hybrid makes speedy entrance in new class

Helicopters

The X3 has the best of both worlds, says Rohit Jaggi

sleek silver shape speeds along the valley, moving faster than its unique sound, more turbine helicopter whine than turboprop growl, would imply.

On a second, return pass hugging the green fields, it slows to a hover and faces the cliffs I am standing on, turning its nose left and right while guarding the same spot in the air.

Eurocopter's X3 experimental hybrid, which will be seen flying by the public for the first time at this week's Paris air show, is intended to have all the benefits of a helicopter while breaching the speed limits inherent in conventional rotary wing aircraft.

Based on the EC155 Dauphin medium twin-engined helicopter, the X3 dispenses with a tail rotor but instead has two side-mounted, forward facing propellers on the end of short wings to counter the torque of the main rotor and provide forward thrust.

Lutz Bertling, president and chief executive of Eurocopter, stresses to me that productivity gains," the aircraft is not about ultimate top speed. "If we can increase cruise speed



says.

The low extra costs come from a relatively simple by 50 per cent but limit architecture. Instead of one acquisition and utilisation output shaft to drive the costs to 20-25 per cent over Dauphin's fenestron tail conventional helicopters rotor, the X3 has two says Jean-Michel Billig, then that will yield high shafts, each driving a varia- executive vice-president of

he

pler, with a double-fin empennage but fenestron. The concept was that it should remain a helicopter,

ble pitch propeller. The rear research and development. of the aircraft becomes sim-"To the pilot it feels like a helicopter," he says. "Yaw is controlled through the no pedals changing the pitch of the propellers, just as in a conventional helicopter but with two propellers rather than one.

"The simple architecture is easy to tune and to verify. It also drives costs down.

The X3 is Eurocopter's solution to the fact that helicopters, while manoeuvrable, are not capable of reaching the speeds of most

aircraft. The aerodynamic phenomenon called retreating blade stall limits rotary wing aircraft speed to about 175 knots normally (see accompanying article), though a Westland Lynx with purpose-build rotor blades holds the ultimate speed record at 217.5 kts.

'We're targeting any kind of mission where speed is of the essence," says Mr Billig. Examples are personnel and equipment supply to offshore energy platforms. The fact that exploration has moved further and further away from land, chasing ever more remote reserves of oil and gas, is already boosting the heliindustry with copter demand for longer-range models. Only helicopters with their vertical landing capability can be used for this purpose. But the increasing distances make

been in development since early 2008 but was publicly revealed only in recent months. But the company has been looking at increasing the speed of its aircraft for 25 years. "The Dauphin broke the world speed record in the early 90s with close to 200 kts," says Mr Billig. "We looked at the tilt-rotor 20 years ago," he adds. "But we decided not to continue with it 10-15 years ago.'

'The simple architecture is easy to tune and verify. It also drives down costs'

Bell and Agusta as the civilian version of the Bell-Boe- there will always be a

Speed sells: that is the hope of Eurocopter, which says its X3 concept's technology can deliver productivity gains

Sikorsky X2 coaxial twin-rotor experimental helicopter which has achieved 250 kts in level flight. But the test schedule has already nudged the top speed of the X3 up from the 175 kts of the Dauphin to 232 kts.

According to the test pilot on the programme, Hervé Jammayrac, who flew those elegant passes along the valley, the lack of a tail rotor and the fact that the main rotor is more level mean less vibration. Smoothness is not the only difference. In the transition from the hover to forward flight the aircraft stays level, rather than requiring the characteristic forward nod of conventional helicopters.

"And the most effective way to climb in the X3 is to accelerate and pitch up," he says, rather than using the collective control to increase power and the pitch of the rotor blades as one would on a conventional helicopter.

The short wings provide "almost 40 per cent of the lift at high speed, and cost a bit of performance in the hover", he adds. But they are not designed to take too much load away from the rotor system - that would slow it down and lose its autorotation capabilities. And that would have a big impact on safety, as helicopters' ability to glide under a windmilling rotor mean they can be landed safely if the engines fail.

Keeping many of the characteristics of conventional helicopters is a key aim of the programme.

The technology is scala ble. Mr Billig says the US has already expressed interest in it for its military heavy lift requirement - for which a four-rotor version of the Osprey has been touted. So far the X3 is turning

up numbers to justify the funding that Eurocopter has put in. It is faster and therefore more fuel efficient than a traditional rotary The BA609, conceived by craft on the right missions. Mr Bertling points out that ing V-22 Osprey tilt-rotor, requirement for convenhas had what is possibly an tional helicopters. But a even more difficult birth mixed fleet where pilots can easily move from one type operators. And for Eurocopter, which is revamping its range, the challenge is how much of X3's technology it should offer its customers. ward by employees, has with the BA609, or with the and on which models.

higher speeds more and more desirable.

Other instances are search and rescue, espewounded but also for evading enemy attack. The X3, born out of

than the military Osprey. cially combat S&R where When it finally reaches cus- to another is attractive for higher speed is useful not tomers it is set to have a just for reaching the maximum cruise speed of 275 knots – but at a high unit price. Eurocopter stresses that number of ideas put for- it is not in a speed race

Compound helicopters Secrets of velocity unwrapped

The pursuit of speed is never easy. But Eurocopter's solution seems disarmingly simple

In most helicopters the anti-torque rotor at the rear, which resists the tendency of the whole aircraft to turn in the opposite direction to the main rotor, spins away. contributing nothing to forward motion.

Even worse, especially at low airspeeds, the tail rotor soaks up power that could otherwise go to the main rotor and be used to lift greater loads. At higher speeds, the fin on a conventional helicopters keeps it flying straight, so while the

tail rotor keeps spinning it is not required to provide much thrust. Eurocopter's design in

effect

moves the tail rotor around the helicopter by 90 degrees so that it faces the front. It can still do its anti-torque job but now it can also provide forward thrust. On the X3 the second forward-facing rotor, providing symmetry of thrust, is also logical. So why has no one done it before? Well, they sort of have. The Bell-Boeing Tilt-Rotor does it in a rather complex way, by mechanically turning the two lifting rotors, one either side of the fuselage on short wings, forwards. Thus the V-22 Osprey military Tilt-Rotor morphs from helicopter to turboprop aircraft.

But others have also done it in a less expensive way. Piasecki, a long-established US helicopter manufacturer, has been working on a compound helicopter that uses a pusher propeller facing to the rear of a conventional helicopter, and a ducting system that directs thrust at low speed in the appropriate direction to resist the torque of the main rotor and provide yaw control. The Piasecki X-49A (pictured) also has little wings - small enough not to interfere too much with downward thrust from the main rotor, but big enough to take some of the load from the main rotor.

Piasecki's SpeedHawk vectored-thrust ducted propeller aircraft, developed with funding from the US Army, is based on the airframe of a Sikorsky YSH-60F Seahawk. But Sikorsky has its own high-speed experimental helicopter, the X2. This selffunded research vehicle uses a coaxial,

contra-rotating main rotor system - two rotors, one on top of the other, spinning in opposite directions - and a pusher propeller at the rear.

The contra-rotating blades mean that the twisting effects on the helicopter body are cancelled out. But they also tackle the main problem when trying to make helicopters go fast - retreating blade stall.

Put simply, this limits the speed of conventional helicopters because the side of the main rotor disc that is turning against the direction of movement stops developing

lift - because of its low speed relative to the parcel of air through which the whole helicopter is moving. This limits the speed of conventional rotorcraft, unless specially designed, to about 175 knots. But the Sikorsky X2 has already logged 250 knots in level flight, and 260 kts in a shallow dive. And Eurocopter's X3, despite the

> company protesting that it is not interested in outright top speed, has notched up 232 knots.

The civilian version of the V-22 Osprey, the nine-passenger

BA609, has long been the subject of friction between the companies that agreed to jointly develop it, AgustaWestland and Bell, but it does have about 70 tentative orders. When it does eventually appear it will fill a niche - though its price is always likely to be considered high.

The military version at least is not that difficult to fly - when I flew the simulator last year at a US Marine Corps air base in North Carolina, I mainly called on my rotary rather than fixed-wing experience. But it does differ from conventional helicopters, and pilots do need specific training.

In that context it could a key advantage for the X3 – and for the X-49A – that their manufacturers claim they are controlled almost exactly like a helicopter. It could mean that an operator would be able to run a mixed fleet of compound helicopters and conventional ones, with pilots able to leap in and out of both. The X3 may therefore lose out on top speed. But on usability, its design may win the race.

Rohit Jaggi

Atomics Reaper.

longer range.

ZK210

Aerospace

Market forces plot flight of unmanned aerial vehicles

Drones

Stretched groups link up for 'entente frugale', says John O'Doherty

When BAE Systems announced last March that it was partnering with the aircraft maker Dassault to develop a new type of unmanned aerial vehicle, it marked the first example of Franco-British co-operation in this defence sector.

It also may have kick-started a new and more collaborative model for UAV building in Europe, prompting two leading industry forces to scramble into partnership in recent months.

The inter-company partnership followed an agreement between France and Britain that was signed in November, and promised to create a combined maintenance system for French

The agreement also decided to make the aircraft carriers of both countries interoperable, but of most immediate importance was also a clause to the agreement committing both countries to closer co-operation in unmanned aerial surveillance vehicles

often up to 40 hours at a time.

companies and their home governments, the agreement also gives the companies access to a greater number of programmes. Unlike the US, no single UAV procurement contract from a It is hardly surprising that the European country is enough to clause on UAVs should be the support a new programme of technology by itself. first of these commitments to

come to fruition. Demand for "This is driven by the princithe flying drones has grown rapple of 'entente frugale'," says an industry source, who declined to idly in recent years, boosted by the conflicts in Iraq and Afghanbe named. istan, where drones such as the

"There's no point in spending General Atomics Predator and enormous sums of money developing the latest technology Reaper are used for surveillance purposes, and, less frequently when it competes with your for carrying out strikes. Their principal ally and neighbour. low weight-to-fuel ratio means Neither country has the money they can often linger over a batto go down that path so they tlefield much longer than tradihave to combine forces." tional ground attack aircraft, Douglas Barrie, of the Interna-

tional Institute for Strategic With an ever-growing military Studies, agrees. need for UAVs, the partnership "This is a market that Europe-

and British nuclear weapons. allows both groups to share the ans want to stake their claim end-product could end up com- the Israeli company Elbit. strikes, much like the General significant development costs of to," he says.

"They want a piece of this new drones. Given the typically close relations between defence market as well, especially as the traditional combat aircraft market is getting smaller. People are buying fewer of these things, because as the platforms get more capable, you don't see one-for-one replacements, you see two-for-one replacements or three-for-one replacements, so the unmanned environment is

an area of growth potentially." BAE and Dassault have already named their project Telemos, after the Greek prophet who warned the cyclops Polyphemus of an attack by the warrior Odysseus.

With the first delivery expected between 2015 and 2020, the BAE-Dassault product will be based on technology developed in creating the Mantis, a prototype UAV built by BAE and already successfully tested last year in Australia. In the medium term the BAE-Dassault

peting for the UK's Scavenger programme, a contract to produce a range of so-called MALE (medium altitude, long endurance) UAVs, used for reconnaissance

But the Anglo-French pair is not the only European group pitching for a piece of UAV action on its home turf.

EADS, the pan-European aerospace group is also hoping to pitch its

own Talarion UAV, and is anxious that the Anglo-French purchase be put out to open competition. These concerns are also held by Thales, whose Watchkeeper drone will soon go into service with the British army.

The logic for industrial co-operation has also made itself felt with both these projects. Watchkeeper draws heavily on the technology of

And although EADS is itself already a pan-European company, last month the group expanded to welcome Turkish participation, after Turkish Aerospace Industries officially joined as a partner of Cassidian, market are testing technology the EADS subsidiary making Talarion.

While European companies are working together on



the next generation of the flying

drones is already being tested.

These unmanned combat vehi-

cles or UCAVs will be designed

to carry weapons and conduct

sault is testing its Neuron UCAV, while BAE is experimenting with the Taranis, and EADS

demonstrators: Das-

This next generation will have

At this stage, all the European

competitors in this emerging

greater stealth technology and

with a proto-type called Baracuda. But with increasing development costs and defence budgets coming under pressure, it is likely that many of these systems will also eventually succumb to the logic

of greater European co-opera-

tion, before they are fielded in



Deadly rivals: Eurofighter Typhoon (main picture) F-18 Super Hornet (top left) and Saab Gripen im Winslet/Katsukiho Tokunaga

Chorus of dismay over \$1,000bn tag

battle.

F-35 costs

Congress hits at 'jaw-dropping' bill for jet maintenance, says Jeremy Lemer

For years the F-35 programme, managed by Lockheed Martin, has been an contractor – supported? easy target for criticism. Development and production costs for the combat jet have spiralled and delivery schedules set in stone one moment have been ripped up the next.

Since the start of 2011, though, Lockheed had

ciently large opportunities to reduce that number by making streamlining decisions along the way.

"How much do the spares cost? How many aircraft are you buying? How many spares are you buying? How many bases are going to operate it? What is the staffing at the bases? Is the staffing ... government - or

And really, on and on." For Lockheed Martin, the stakes are high. The F-35 is its single largest programme and will be the key driver of its revenues and profits over the next 30 years.

Still, Lockheed says that adopted a more positive it will not be able to protone, arguing that efforts to duce its own counter-estireshape what is the Penta- mates until about 2015, gon's largest procurement when it has collected about project were finally paying 200,000 flight hours worth of off in better test results and data, which will feed into improved performance. "more realistic" assumptions. In the meantime patience is wearing thin. Buying the F-35 was supposed to cost \$233bn, or an average of \$69m each, with delivery to the services starting in 2008. But cost estimates have soared to about \$385bn, or \$133m each, and the service entry date

Contractors lured as India and Brazil rearm

Defence

Focus is on countries renewing fighter fleets to match economic clout, writes John O'Doherty

he rapid growth of the Brazilian and Indian economies is the subject of much detailed analysis, but the development of these countries' militaries often gets far less attention. That is about to change however, as both countries seek to bolster their defence capacity, and in so doing, they are attracting the attention of the world's largest defence groups.

This year the world of military aerospace was focused on the question of who would be awarded a \$35bn contract to provide 179 refuelling air-tankers to the US air force. The selection of Boeing drew a line under one of the largest and most contentious contracts in military aerospace in ageing fleet of Russian-built airrecent history. But as the fervour of this contract starts to fade, two new military aerospace contracts are coming into focus.

The Brazilian and Indian governments are evaluating a of MiG 21s," says WPS Sidhu, a number of fighter aircraft as part senior fellow at New York Univerof competitions to re-equip their sity's Centre on International Coair forces with the military heft to operation. match growing economic clout.

With a combined value of potentially more than \$17bn, the two Indian Airforce. Even with all the competitions are attracting the attention of the main defence very serious depletion in the groups. Only one aerospace com- number of squadrons of the pany is competing in both competitions: Dassault of France is offering its Rafale fighter.

In Brazil, the other competitors are Sweden's Saab, which is proposing the Gripen. Boeing is competing with the F-18 Super Hornet.

In addition to the Rafale, India is now only considering the Eurofighter Typhoon, having ruled out Saab's Gripen as well as a Russian MiG and Lockheed Martin's F-16 in a shortlist it drew up in April.

The stakes are high for the companies involved, which are keen to secure export opportunities for their aircraft. For example, outside of its home market of France, Dassault has yet to secure any export orders for the Rafale, and the F-18 has only secured sales from Australia and the US Navy.

For the countries themselves, the competitions highlight their growing wealth and eagerness to have a defence capacity to match their economic power. It also comes as both countries take notice of the evolving security situations in their neighbourhoods.

For India, the need is simple. Its craft are fast becoming unusable, throwing into contrast the growing strength of China and Pakistan. "All the juice has been squeezed out of the current fleet

"These constitute more than a third of the rapidly depleting fixes and extensions, there's a Indian air force.

In the case of Brazil, analysts highlight that the fighter contract have played a role in the decision

defence capacity in the region, and Brazil's realisation of a need to protect the still embryonic offshore oil industry.

"Across South America, countries are re-equipping their militaries as well, and we need the ability to maintain a balance in the region," says Marcelo Suano, director of CEIRI, a thinktank in São Paulo, who points to the increasing military expenditure of Venezuela, Colombia and Peru.

"We're a country the size of Europe, and our air force is relatively small. The investment in the fighter jets is actually small compared to the amount that is being spent on the navy.'

'All the juice has been squeezed out of the MiG 21s ... more than a third of the rapidly depleting Indian Airforce'

In addition to strict cost considerations, both countries will have to balance the strategic implications of their choice. Choosing military hardware from a certain country can cement political ties with that country, making defence spending another form of diplomacy.

India has already signed an agreement with Russia to develop jointly the next generation of fighter jets, the so-called fifth generation, of which the Lockheed Martin F-35 Joint Strike Fighter is the most high-profile. This may

comes amid a broader updating of not to put the MiG-35 on the short list, as India sought to forge a strategic link with a second partner.

Similar considerations are at work in Brazil, where strong links have already been established between the French and Brazilian navies. Brazil purchased an aircraft carrier from France and the two countries are collaborating on nuclear propulsion for submarines. However, the political nature of the decision began to come under scrutiny.

"There were complaints in the media in Brazil that the process had been politicised to favour the French bid," says Paulo Sotero, director of the Brazil Institute at the Woodrow Wilson Institute in Washington DC.

This pressure, combined with a budgetary squeeze, led the new president, Dilma Rousseff, to announce that no decision would be made on the fighter competition until the end of this year at the earliest.

"It was in part a financial consideration, and in part it also reflected a desire to re-situate this decision back within a technical framework to say 'we'll do whatever corresponds best to the needs of the air force'," says Mr Sotero. Aside from concerns over political strategy, the winner of the competitions will also be decided by which offers the best deals in terms of so-called "offsets" - additional benefits given by a winning company to the purchasing nation. Offsets can come in the form of offering to build part of the aircraft in the country, or limited transfer of the technology involved to help build the domestic aerospace industry.

Mr Sotero points out that Bra-

zil's national defence doctrine explicitly mentions the military's role in fostering the development of the defence industry alongside other countries.

Stephen Cohen, a senior fellow at the Brookings Institute and an author of a book on the modernisation of the Indian military, says the Indians will also be searching for help in building up an indigenous defence industry

"One reason India is the world's largest arms importer is that they can't make anything themselves,' he says, pointing to a costly failure to build the H-24 jet based on German technology, and the lengthy delays in building a light combat aircraft. "The Indians have a huge demand for offsets."

Mr Cohen reckons that offsets concerning the seemingly unsophisticated issue of metallurgy would be especially attractive to India.

"Metallurgy in engines is critical, because that means the planes don't need to be repaired or rehabilitated after every two flights. Western planes are much, much better in that regard and India does not have the latest technology to do the really cutting-edge stuff." Mr Cohen's view echoes that of the US ambassador to India, who in cables released by Wikileaks, criticised standards at an Indian aerospace factory he visited, where a local company was assembling aircraft kits made by BAE Systems.

Brazil is expected to make a decision this year or early next. India estimates a decision will be made by the end of March. However, not all those familiar with the competition believe the decisions will come so quickly.

But in recent weeks the company has come under pressure over a new issue. A fresh estimate of the total life cycle costs – the money required to operate and sustain the aircraft – has triggered a wave of angst among politicians and Pentagon officials.

According to the latest report on the F-35 programme prepared by the Pentagon, maintaining the fleet of jets through their entire working lives will cost more than \$1,000bn, a number that several influential congressmen have

described as "jaw-dropping" and "unsustainable". "If we live the estimates,

we cannot afford to pay the Pentagon's top procurement official, told a senate hearing in May, adding that "our objective is to make

sure that those estimates do not come true" Vice-Admiral David Venlet, who manages the F-35 for the Department of Defence, has said that his unit will prioritise refining and reducing estimated sustainment costs in 2011 - in the same way it focused on

fixing the development and manufacturing plans for the jet in 2010. All of that could spell

trouble for an aircraft that was pitched as a cost effective way to upgrade the US fleet. Lower maintenance and support costs were key to that goal as they regularly add up to 70 per cent of the total bill for owning a weapons system. This isn't just another

For years Lockheed insisted that the running costs of the aircraft would be less than equivalents such as the F-16. But those numbers have fallen by the wayside. The Pentagon now expects the F-35 to cost about 33 per cent more than the F-16s it aims to replace. Lockheed has pushed

back against those numbers, describing them as "sensationalised". Executives point out that the \$1,000bn figure is based on operating 2,443 aircraft over 52 years, from more than 50 bases and include adjustments for inflation and fuel

costs "It is a big model that has come up with a big number," Bob Stevens, chief executive of Lockheed, said in May. "But when you come up with a big number month. "We looked ... We like that ... there are suffi-

much compared to what you will pay. Senator John McCain concurs. "In my view, the program is now at a watershed moment," he said in May. "With austere defence budgets for as far as the eye can see, the [F-35] programme must show now it can deliver [F-35] aircraft as needed on time and on budget." Both Congress and the

Pentagon have limited options. "There are not good alternatives to the [F-35] for either our services or our international partners," Mr Carter said bluntly last want the aeroplane.³

remains unclear. Earlier in the year the Pentagon announced a new plan for the combat jet, adding extra funding and test aircraft to the development

'These sorts of figures make the service chiefs go that much," Ashton Carter, weak at the knees

> phase, slowing the speed at which production ramps up and placing one variant on probation".

Bill Sweetman, editor in chief for Defense Technology International, who has followed the F-35 for years. argues that whatever the eventual total, if sustainment costs do not come down it could spell trouble for the programme.

"These sorts of figures make the service chiefs go weak at the knees because they will have to reduce numbers to stay within budget, as there is no more money," says Mr Sweetman. But if numbers are cut then costs per aircraft will inevitably spiral. "People are waking up.

defence acquisition," he

says. "The \$1,000bn dollar

figure is an indicator that

you have a spent a fortune

and there are a lot of sunk

costs but that is not that



Mixed messages: the Rafale is in two big fighter contract races; pilots praise it but the aircraft has yet to find an overseas buyer

Fightermaker locates dividend in Libyan skies

Dassault Aviation In spite of recent reverses, the company can point to positive signs, says **James Boxell**

hough it may be insensitive to point it out, the imposition of a no-fly zone in the skies above Libya has offered something of a showcase for Dassault Aviation's Rafale fighter jet in recent months.

Executives at the French aircraft manufacturer do not want to be accused of using the conflict as a promotional tool. But there is a clear sense that the Rafale's performance in Libya could provide some assistance to France in its, so far forlorn, search for the aircraft's first export order.

puts it: "The Rafale demonstrated a full spectrum of capabilities, routinely flying air-toair, air-to-ground and tactical or strategic reconnaissance missions in the same flight during the same operational sortie. Omni-role is an accurate description of this aircraft's capabilities. Positive reviews about prod-

uct performance are particularly welcome at Dassault during a time when the family-owned aircraft maker has suffered problems in usually reliable parts of its business.

As well as the perennial struggle to find an overseas buyer for the Rafale, the company's successful private jet business has also been hit by recent bad luck. Like other makers of corpo-

rate jets, the French company has had to cope with the global financial crisis and the subsequent cancellations of orders as their spending. But while the

shown some signs of recovery this year, Dassault was forced last month to ground its worldwide fleet of Falcon 7X aircraft after one encountered an inflight anomaly - though it landed safely. As a result 112 Falcon 7Xs, which cost about \$50m apiece, were out of action at one point although the European Aviation Safety Agency has cleared two-thirds of the

fleet to start flying again. On a more positive note, the company launched last month the latest addition to its Falcon family, the 2000S, which will probably be available for delivery in early 2013. The \$25m jet

has a large cabin but will, the company claims, consume 10 per cent less fuel than aircraft 20 per cent smaller. Company executives are also

hoping for a revival in the private jet market, supported by strong demand from China. wealthy customers reined in Charles Edelstenne, Dassault's chief executive, has said that

As a company spokesman market for private jets has the "potential for long-term growth in China is huge". After posting negative net

orders for its business jets in 2010, meaning cancellations outstripped new sales, the company says it has seen a pick-up in orders in 2011 and no recent cancellations - though the health of the business remains tied to the health of the global economy.

And even though Dassault, along with the French government, is still waiting anxiously for the first foreign order of a Rafale, there has been some positive developments on the fighter jet front.

First, the Rafale was shortlisted alongside the Eurofighter Typhoon by India – which is looking to place a multibilliondollar order for 126 combat jets

- in preference to rival aircraft from the US. Mr Edelstenne says the company is in the running in eight international fighter jet competitions, including a potentially lucrative order

from Brazil, which is being realises it will not be able to go courted assiduously by the French.

And much smaller in terms of short-term revenues – but strategically crucial as Dassault and France think about how they can sustain their fighter jet business over the next few decades – is a new €1bn joint ven-

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ture with BAE Systems, the British manufacturer, to develop an unmanned combat aircraft.

A senior executive at a rival defence company says that the tie-up, supported by the recent Anglo-French defence treaty, is a sign that the Elysée Palace

it alone when building future generations of fighter jets.

The French military, which has promised to buy a total of 286 Rafales, has been taking roughly an aircraft a month, or 11 a year, which is the minimum to keep fighter jet production going. Given the pressures on budgets it will not be able to repeat such largesse on future projects.

"The government is worried about its future in military jets and this alignment with BAE is absolutely part of the strategy to retain a capability in France," says the rival executive. "It is not a capability that will continue autonomously but will have to be joined up with others in Europe because otherwise no one will be able to

afford it." Another thing the BAE deal highlights is the increasingly important role being assumed by Dassault in the reshaping of the French defence industry.

Its 26 per cent stake in Thales, the French defence electronics manufacturer, makes it a driving force behind the anticipated asset swap between that company and Safran, another aerospace specialist. Some analysts think the move will make Safran a purer aerospace company and Thales more militarily focused.

For Jason Adams, an aerospace analyst at Nomura, the strategic influence of Dassault is increasing - a worry for EADS. its Franco-German aerospace rival.

"I think Dassault is going to be at the centre of the longerterm consolidation of the French defence and aerospace industry," Mr Adams says.

"EADS is a little bit concerned it may lose position in the French defence market because it is seen as Franco-German while Dassault and Thales are pure French.." he adds. "As we know, the French like national champions.

'Hand to mouth' existence for business jet producer

Cessna

The company says that trade will take off next year, writes Hal Weitzman

The ups and downs of the economic cycle are nothing new to Cessna. The first aircraft the Wichita, Kansasbased company produced, the DC-6, earned its certification on October 29, 1929 - the day of the Wall Street Crash. Production stopped completely between 1932 and 1934 on account of the Great Depression.

now one of the world's biggest makers of light and midsized business jets, utility turboprops and single-engine aircraft, has been through more than a little turbulence. Its order book was decimated as the economic downturn prompted wealthy individuals and companies to stop buying new aircraft, while demand from fractional ownership companies plunged.

The aircraftmaker eliminated some 8.000 jobs in 2009 and 2010 – more than half of its workforce – as it struggled to cope with the recession. Cessna shut one factory in Oregon and mothballed three manufacturing facilities in Georgia, including one that had opened only in August 2008.

The company cut its production chief executive. schedule and cancelled development of the Citation Columbus, an eight-seater business jet with a range of 4,000 nautical miles, a mock-up of which had been shown at the 2007 Paris Air Show, forcing the aircraftmaker to write off \$43m in development costs and return \$10m in economic incentives to the City of Wichita.

But the most highprofile Cessna casualty of the economic downturn was Jack Pelton, its chief executive of seven years, who was pushed out last month by Textron, Cessna's parent company.

In late 2010, Cessna said it was beginning to see signs of an upturn in demand for new business jets, including fewer forfeited deposits. In ery. Corporate profits, which correlate company's money in anticipation of an upturn that did not materialise.

That led to rising costs and deepening losses for Cessna in the first quarter of this year, in which the company reported a loss of \$38m, compared with a loss of \$24m in the same period last year, even though sales rose by nearly 30 per cent to \$556m. That result helped drag down Textron's quarterly earnings, which fell short of analysts' expectations.

"While there are a number of items in the quarter that contributed to the magnitude of the loss; I would say the underlying operational performance In recent years, however, Cessna, at Cessna was disappointing," Scott Donnelly, Textron chairman and chief executive, said as he unveiled the results.

A few weeks later, Mr Pelton was out - just days before the company hosted an investors' conference. While Mr Donnelly was extravagant in his praise of the outgoing Cessna chief, he made it clear that he wanted a different approach. "We have taken a number of actions over the past couple of years at Cessna but clearly have more to do," he said.

In looking for a replacement, Mr Donnelly looked to GE, which he left in 2008 to join Textron, naming Scott Ernest – former head of GE Aviation's supply chain unit – as Cessna's new

Mr Ernest faces a considerable challenge. The company antici-

pates that business jet demand will be flat this year and told investors last month that it was working "hand to mouth". essentially building business jets as orders come in. Cessna, does. howthat business will pick up next year in 2013.

line with recov-

response, Mr Pelton spent more of the closely with aircraft orders and deliveries, are expected to increase, while there are signs that average daily utilisation of Cessna jets is starting to increase. The company plans to hire 350 engineers over the next few years. So is the worst behind Cessna? "I hope so," says Mark Paolucci, the company's senior vice-president for sales and marketing. "Every time someone says it can't get any worse, I knock on wood.

'Typically we see shipments following the rise or fall in corporate profits by about two years. We're about 18 months after the beginning of the rise of profits, so we feel like any time now it should pull itself up, barring any further disasters.'

Analysts will need more convincing that any pick-up will make a significant difference to the bottom line.

"Given the lack of volumes and some long-term supplier contracts ... margins will probably remain depressed at Cessna well into 2012," Robert Stallard, an analyst at RBC Capital Markets, wrote in a recent research note.

Emerging markets are an important part of the company's strategy. About half of Cessna's sales come from the US, with Europe, the Middle East and Africa making up a further quarter. Nearly half of the remaining customer base is in Latin America, where Mr Paolucci says demand in Brazil and Mexico has remained robust.

Cessna is looking to expand in China and India. However, the company will find it hard to expand on its 23 per cent market share in China, where Gulfstream and Dassault lead the market, selling business jets that are larger than Cessna's offerings.

Cessna is adjusting its advertising in China to present its jets as more luxury products than corporate workhorses

Following several years in which it released no new products, Cessna announced last month that the Citation Ten – an updated version of its Citation X, the world's fastest certified civil airever, forecast craft - will make its first flight by the end of the year, with first deliveries of the jet planned for the second half of

Cessna says the Ten will fly higher, economic faster and further than the existing Citation X, with 5 per cent better fuel economy The new aircraft will have a maximum range of 3,245nm — making trips such as New York-London or London-Dubai within reach.

> Facing a challenge: Scott Ernest. new Cessna chief executive

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US prepares to take a breather in space race

Nasa

The space shuttle's final journey will leave the US relying on its former Cold War rival, reports **Clive Cookson**

or manned spaceflight, next month will see the end of an era that lasted 30 years. The 135th and final launch of a US space shuttle is scheduled for July 8, when Atlantis takes off with a crew of four from the Kennedy Space Center in Florida, on a 12-day mission to the International Space Station (ISS).

The last shuttle flight will be a particularly emotional event for National Aeronautics and Space Administration (Nasa) staff in Florida, at the Johnson Space Center in Texas and the Marshall Space Flight Center in Alabama, who have devoted their working lives to the shuttle programme and, in many cases, now face redundancy

Many other Americans not directly involved in the space industry are noteworthy science has emerged so also saddened that their country, far from experiments carried out in which has led the world in manned the microgravity environment of

longer have the means to put astronauts into orbit.

For the next few years — until the private space sector has met the challenge laid down by President Barack Obama of developing a commercial crew vehicle — the US must rely on Russia's Soyuz rockets to take astronauts to and from the ISS. Nasa has booked places on 10 Soyuz flights to the end of 2013.

Soyuz has a very small capacity for carrying non-human payloads, compared with the shuttle. For the time being, Russia's Progress space cargo tug and the European Space Agency's Automated Transfer Vehicles will be able to take up some of the slack in lifting supplies up to the ISS — and Nasa has contracted with the commercial US space industry to supply future cargo flights.

The world's space agencies have spent an estimated \$100bn building the ISS over the past 13 years and are committed to keep it going, with a crew of six, at least until 2020.

With construction of the ISS complete, the focus is turning to its role as a huge orbiting laboratory. Little

flight since the mid-1960s, will no space, but ISS research managers insist that a worthwhile programme is now under way, in fields ranging from materials science to biotechnogy.

The biggest single research project is the \$1.5bn Alpha Magnetic Spectrometer, which the shuttle Endeavour delivered on its farewell flight last month. The AMS is designed to detect cosmic rays and rare subatomic particles from outer space. Physicists hope it will help them to pin down the identity of the mysterious "dark matter" that is believed to pervade the universe - and also to discover whether space contains any particles of anti-matter.

While the US private sector concentrates on producing spacecraft for use in low Earth orbit, Nasa has switched the focus of its technology development to rockets and crew vehicles that could take people further into the solar system, as requested by President Obama when he gave the agency a new strategy last year.

Although the president cancelled the costly Constellation programme that the previous Bush administration had intended to replace the shuttle, parts of Constellation are being salvaged and adapted for use as deep space transport.

Charles Bolden, Nasa administrator,

Final approach: the end of space shuttle flights will mark a shift in the world order on space announced last month that designs originally drawn up for the Orion crew vehicle within Constellation

would form the basis of a new Multi-Purpose Crew Vehicle (MPCV). "We are committed to human exploration beyond low earth orbit and look forward to developing the next generation of systems to take us there," he said.

Lockheed Martin, which was working on Orion, will be the chief contractor for the MPCV. The initial version of the spacecraft will carry four astronauts for 21-day missions. It is designed to be 10 times safer during

tle, which killed 14 people in two accidents over 30 years (Challenger in 1986 and Columbia in 2003)

At the same time Nasa is struggling to decide how to develop a heavy-lift rocket to send the MPCV or another future crew vehicle into deep space perhaps to visit an asteroid or Mars.

One option is to build on the 1960s legacy of the Apollo programme, which lives on in the new J-2X rocket engine that Nasa is about to start testing at its Stennis Space Centre in Mississippi. J-2X, built by long-standing Nasa contractor Pratt & Whitney Rocketdyne, is a derivative of the Satascent and entry than the space shut- urn upper-stage engine that sent judgment.

astronauts to the moon more than 40 years ago.

AFP/Getty Images

Another option is to bring in newer but less proven rocket designs from companies that have not traditionally been part of Nasa's circle of contractors within what used to be called the military-industrial complex.

The selection of Lockheed Martin, another traditional aerospace contac-tor, to develop the MPCV "does not indicate a business-as-usual mentality for Nasa programmes," insists Douglas Cooke who runs the agency's Exploration Systems Mission Directorate. Outside observers are reserving



would be severely tested at many of the more out-ofthe-way airports I have been to in Africa and Asia. It would be difficult to sound confident about the outcome of a similar argument if one's evidence were changing form and leaking on to the floor as one spoke.

Business jets under pressure

A total of 128 new business jets were delivered by Boeing, Airbus and the six leading business-jet manufacturers in the first quarter of this year, according to JPMorgan's latest Business Jet Monthly.

That was 22 per cent down on the same quarter in 2010, and about half the level of deliveries in the last quarter of 2010.

At the same time revenues from deliveries fell 25 per cent on the same quarter last year, and 42 per cent over the previous quarter.

For past year as a whole,

12 per cent lower than the

and 34 per cent down on

the peak in 2008. Cessna,

biggest loser. It delivered

previous year, in unit terms,

deliveries of jets were

the biggest maker of

business jets, was the





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Its chairman and chief executive, Richard Lugg, has a background in engines. And its chief operations and technology officer, Bernard Rousset, has worked on Airbus projects.

or so. It will also have to

business plan, including a

have a pretty robust

builder for the aircraft.

That's a start. The fact that supersonic flight is banned over many countries, including the US, seems almost a detail by comparison with those challenges.

Icy resolve in security line

Picture the scene. A rather chilly. over-air-conditioned security area at a big international airport. "Do you have any liquids in your bag?" asks the security guard. "No," replies the passenger confidently. "Well, what's this then?" The security guard, ferreting through the bag, is sure he

has saved the airline sector from another fiery disaster. "That's not liquid," explains the passenger patiently. "It's water, but it's in the form of ice." He adds helpfully: "That's solid, not liquid.'

Cue a rather long wrangle over the physics of matter. My informant tells me that this scene ended with the passenger being allowed through the barriers.

The quietly difficult passenger was in Singapore's Changi airport, but could have been almost anywhere. And the scene from a traveller's travails does illustrate the point that rules on liquids are past their sell-by date. In the UK, for example, they were supposed to be relaxed two months ago but were not.

The iceman method of highlighting the inconsistencies and inefficiencies of security screening would work at many newer airports where the temperature is chillier than the security guards' reception, whatever the weather outside.

178 jets in 2010 compared with 289 in 2009. Embraer of Brazil and Dassault Aviation of France increased the number of business jets they delivered, though, as did Gulfstream. Boeing and Airbus. Last year, the trend of a divide in the market continued, with heavy jets gaining market share, and medium and light jets losing. In 2010, heavy jets

accounted for 79 per cent of the market by value, with medium jets at 15 per cent and light jets at just 6 per cent. In the all-important

market for used jets, where huge inventories of aircraft are also affecting sales and prices of new jets, there was also mixed news. The number of jets for

sale as a percentage of the active fleet fell in May this year by a mere 0.2 per cent - but that took it to the lowest level since September 2008. However, asking prices also fell, by 1.4 per cent.

G650 resumes testing

Flight testing of the new range-topper for Gulfstream Aerospace, the G650 largecabin, ultra-long-range business jet, resumed at the end of May after being suspended in the wake of a fatal accident in New Mexico on April 2. The agreement of the **US** Federal Aviation Administration to the resumption of testing puts the programme back on track for first deliveries next year, according to the Georgia-based company.

But even without scheduling delays, it

> Flying again: Gulfstream's G650