STRAIR
CONNECTING AIRPORT REGIONS


# Aircraft Maintenance Repair and Overhaul Market Study.

## Glasgow International Airport.


Glasgow Airport is represented by
**Renfrewshire Council**
**Scottish Enterprise Renfrewshire**
**BAA Glasgow**


Sweden / Stockholm Airport Region / Office of Regional Planning and Urban Transportation
Sweden / Gothenburg Airport Region / Municipality of Harryda
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Scotland / Glasgow Airport Region / Renfrewshire Council
Belgium / Ostende Airport Region / West Vlaamse Intercommunale

Maria Komendantova
Project Manager

**Oslo Teknopol**
Lead Partner STRAIR

Richard Gibson, Business Development Manager.
Ken Goldie, Senior Project Executive. James Cunningham, Head of Economic Development

**Renfrewshire Council**
STRAIR Component 2 Partner

John Borkowski

**MSP Solutions**
Author of this report

# presentation

The STRAIR (Strategic development and co-operation among airport regions) project was initiated in 2004 by seven members of the Economic Development Interest Group of the ARC (Airport Regions Conference), which represents more than 30 European cities and regions with major international airports. They share the belief that airport regions have a significant role to play since aviation is a key factor behind economic growth.

STRAIR is an INTERREG IIIC-supported project with eight partners from seven regions: the Canary Islands, the municipalities of El Prat and Viladecans (near Barcelona), Härryda (near Gothenburg), Oslo, Renfrewshire (near Glasgow), Stockholm and West Flanders.

All of us aim to improve development of the airports in our regions as well as manage the economic, environmental and social impacts of this development.

This report 2B is the result of a study within Component 2 of the STRAIR project: Innovation and business development directly related to airports. It was produced by MSP Solutions on behalf of Renfrewshire Council in cooperation with the other two Component 2 partners: PROEXCA (regional development agency of the Government of the Canary Islands and West-Vlaamse Intercommunale (WVI), the association of municipalities of the Belgian province of West Flanders.

For Renfrewshire Council, the STRAIR project has been a valuable opportunity to learn lessons from the ways other European regions support the economic development of their airports regions. We hope likewise that you will find valuable lessons for your respective regions in this Report.

www.strair.org
info@strair.org

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# Executive Summary

## A. Introduction

The study was required to enable the Sponsors of Glasgow Airport, Renfrewshire Council, Scottish Enterprise Renfrew and BAA Glasgow, to gain a thorough understanding of the current and prospective European aircraft maintenance, repair and overhaul (MRO) market. This understanding will allow them to take a systematic approach to the possible development of a new major MRO facility at Glasgow Airport.

The last section of this study focuses on specific aspects of the UK market that have particular relevance to Glasgow Airport, but in principle the general market analysis could be applied to the establishment of a new MRO facility at any of the airports in the regions of the other STRAIR partners. In that case, one would need to undertake additional analysis of the relevant market as well as possible additional factors and considerations. The analysis of these factors and considerations is not within the scope of this report, but it is safe to say that the broad conclusions may well apply to locations with similar labour and other cost levels as the Glasgow region.

## B. Outline of the Study

The study begins with an outline of the air transport industry's growth prospects. The next two sections examine the main issues involved in managing the MRO business and survey the current market in Europe. The final section explores some specific issues relating to the development of a new MRO facility specifically at Glasgow Airport.

### Air Transport Industry Forecast

MSP Solutions has prepared its own growth forecast of the aviation industry. This estimates the number of aircraft by various categories until 2035. The forecast was developed using three steps:

- A macro-economic forecast is developed using US Department of Energy assumptions for GDP growth and oil prices.
- Traffic forecasts were then derived, using income and price elasticity factors.
- Demand for aircraft was then calculated from the traffic forecast.

The forecast covers the global fleet size. The number of aircraft based in Europe is also forecast in some detail by the various aircraft categories.

The global fleet is expected roughly to triple to 44,000 aircraft and the European fleet to nearly double. In spite of the shift towards larger aircraft, more than half of the aircraft in service in 2035 will be narrow-bodies. This situation arises as availability of adequate flight frequencies is still judged to be critical, even in the maturing markets.

A sensitivity analysis is also included in the study, using more cautious assumptions including the impact of steadily increasing oil prices. The resulting growth rates are roughly half of the mainstream forecast. Nevertheless air traffic still manages to double by 2035 and fleet size increases to nearly 24,000, a still substantial growth rate of 60%.

While the global fleet will continue to grow (even in the alternative scenario) this does not mean that the MRO market will also grow. Over time the maintenance requirements per aircraft are tending to decline because each generation of aircraft is engineered to require less maintenance than the preceding generation.

### MRO Business Issues

MRO activity was initially the domain of the airlines with very little work outsourced to independent providers or manufacturers. This situation has progressively changed over the years as increasing financial pressure on airlines has forced them to seek ways of reducing costs. Specialist MRO providers have developed who can use the volume of their business and specialisation to do the work at lower unit cost, often by choosing locations with lower labour and set-up costs.

A number of national airline carriers have withdrawn from the business totally by subcontracting work. Other airlines such as Air France have separated the MRO operation from their airline business and transformed their engineering and maintenance activity into separate specialist companies. Finally, some airlines have continued doing work in-house in an integrated organisation.

The traditional role of the MRO provider is also changing with much more of a total support function rather than a one-off approach to the work. Increasingly, airlines are looking for a one-stop solution based on a long-term commitment to the provider. A good recent example of this was the 10-

year agreement between SR Technics and easyJet for total engineering and maintenance support of the easyJet fleet.

The continual financial pressures in the air transport market, coupled with the introduction of low cost carriers, has forced further change on the existing MRO providers, with a reduction in prices and a transfer of work to lower cost providers and countries.

In geographical terms, there is a developing trend to move into China, the Far East and South America in pursuit of lower labour costs. In the survey carried out as part of the study, most MRO providers said that the concerns over service quality in these emerging areas were gradually receding. Within Europe there has been a move to lower cost countries in Central and Eastern Europe; e.g. Poland and Hungary.

The development of new technology aircraft, coupled with pressure on the manufacturers to reduce maintenance tasks, has resulted in a very significant reduction in both work scope and work frequency. This has resulted in a sharp fall in the MRO load as a whole, leading to some under utilisation of existing resources.

In the UK there is a surplus of MRO resources at present, with some providers unsure and others quite optimistic about the future prospects for the Industry.

Consolidation of MRO providers in Europe continues with a few dominant providers buying into others or taking them over entirely. These larger providers are also expanding into both Eastern Europe and the Far East, again to take advantage of economies of scale and lower labour costs.

**MRO Opportunities at Glasgow**

This section considers the challenges that will have to be overcome to develop an MRO facility at Glasgow Airport. These include the barriers to entry and the key success parameters, as well as characteristics of the Glasgow region that would make it attractive for a new MRO provider to enter the market. Incentives are also briefly examined in this context, to the extent that they are available.

MSP Solutions conducted interviews with senior managers from a selection of five airlines and MRO providers. These interviews highlighted the primary concerns of the MRO business as downtime, quality and cost. There is considerable interest in finding new solutions, especially by utilising MRO facilities in Asia where labour costs are lower and adequate quality can now be assured.

There is, at first sight, only limited support for utilising an MRO facility at Glasgow. This may be due in part to the potential participants having had little time to consider such a move seriously.

There would however be some interest in the prospect of moving into a purpose-built facility. So far MSP Solutions can find little evidence of any willingness to invest major capital to develop a facility in Glasgow – or in any other UK location, for that matter.

However, three of the companies that were interviewed expressed varying degrees of interest in a Glasgow MRO base, while only one of the five dismissed the possibility out of hand.

## C. Conclusions

The study boils down to answering four key questions:

- How will the MRO market grow over the period to 2035?
- Is there an economic MRO development opportu nity for Glasgow and what would this be?
- Which acceptable organisations might be interested in developing a major MRO facility at Glasgow?
- How can the Sponsors attract such organisations to create the desired MRO facility at Glasgow?

**How will the MRO market grow over the period to 2035?**

As noted above, it is anticipated that the aviation industry will continue to grow over the foreseeable future. Even in the event of continuing escalation of fuel prices and weak economic growth, the industry will continue to grow.

Growth in MRO activities will not follow the same trends. Each new generation of aircraft is more sophisticated than its predecessor. This improvement has included major reduction in maintenance requirements. Thus the specific engineering maintenance requirement per aircraft will continue the current trend of decline. In broad terms, MRO growth in the mainstream scenario will be less than half of the traffic growth. In the high fuel price scenario, there could possibly be no growth at all in overall MRO activity.

**Is there an economic MRO development opportunity for Glasgow and what would this be? (Please note the response to this question is specific to Glasgow Airport.)**

MSP Solutions believes that there is an economic case for MRO development at Glasgow. In view of the growth prospects, this cannot be based purely on providing additional capacity to meet demand. Instead it is crucial that a new MRO facility will have to be developed on the principles of providing high quality at reasonable cost.

The term "reasonable cost" is chosen carefully. It will not be possible to match the lowest unit costs worldwide, especially in Asia. However, it should be possible to offer competitive prices compared with Europe, and to make an advantage of geographical proximity to the operators.

Given the scale of the market, MSP Solutions believes that a Glasgow MRO facility would be better placed to look for business maintaining narrow body aircraft of European airlines. There may also be some opportunity for smaller wide-body aircraft such as B767, B787 and A350. It is unlikely that Glasgow will be able to compete for business servicing the larger wide-bodies (A380, B747) as the market size will be smaller and the investment in resources much greater. There are already well-established large wide-body aircraft MRO facilities in the UK, including British Airways Engineering at Cardiff Airport. The A380 will also be maintained at least two major European locations which will be more than enough to support the initial aircraft fleets.

**Which acceptable organisations might be interested in developing a major MRO facility at Glasgow? (Please note the response to this question is specific to Glasgow Airport.)**

The interview process indicated that there are operators and suppliers who would consider using an MRO facility at Glasgow. Primarily these are UK based companies.

At this stage, the interviewed companies wish to keep the discussions confidential by not being publicly identified in the report. If the Sponsors wish to develop the proposals, MSP Solutions would be willing to contact those organisations already interviewed as well as others who might be interested in such a project.

**How can the Sponsors attract such organisations to create the desired MRO facility at Glasgow? (Please note the response to this question is specific to Glasgow Airport.)**

It is essential that careful planning and implementation should be aimed at developing a new MRO facility that meets the main concerns of the industry, i.e. downtime, quality and cost.

The issue of state aid or other grants could also be extremely important. Currently Regional Selective Assistance (RSA) offers grants up to 20%, but the level will be determined by the rules prevailing at the time of application. New European Union rules apply from the beginning of January 2007.

However, raising finance to complete a major MRO project appears to be the biggest challenge. The interviews reveal that in general, MRO organisations

would be reluctant to invest a large amount of their own capital in such a project. It is possible that there might be some negotiating room here that could only be identified in serious detailed discussions on a more defined project, but MSP Solutions believes that the sponsors would be advised to place a low probability of this outcome. While it should be possible to partner with one of these organisations at all stages of the development process, it must be borne in mind that they will be seeking what amounts to a turn-key operation. This means that financing of the project will have to be found outside the existing MRO industry.

It may be possible to attract potential MRO suppliers to Glasgow, provided clear thought has been put in to defining the specific terms of a potential contract, together with a clearer set of time scales and cost estimates for a defined project.
The interview process shows that there are operators and suppliers who would consider using an MRO facility at Glasgow. There may also be other European or overseas MRO organisations that could be interested in a new facility at Glasgow. This would need further investigation.

In any event a new Glasgow MRO facility would have to meet the main concerns of the industry, i.e. downtime, quality and cost. These issues would have to be addressed at all stages of developing a plan and in the implementation. In outline the next steps could be:

- Define the size and scope of the proposed MRO facility as an outline project. This would be a 4 bay facility with room for further expansion at a later date.
- Ascertain the position of the existing operators at Glasgow, what would happen to the sites they occupy at present.
- Attempt to reach a consensus with other maintainers at other Scottish airports that they either relocate or at the least do not attempt to compete directly with Glasgow.
- Identify a number of potential MRO tenants and/or investors.
- Evaluate the economics of the potential project based on realistic estimates of the costs (capital expenditure and working capital), income streams representing a realistic earning potential of the defined outline MRO facility.
- Evaluate the project under a variety of financing options.
- Discuss the project with banks and venture capital organisations to gauge their level of interest.

For the project to advance it may be necessary for the Sponsors to put up some equity capital. BAA participation would qualify for the EU grant aid, but there might be problems if Scottish Enterprise and Renfrewshire Council as Government Agencies were to take a majority stake. Involvement of British Airways either in the form of an equity investment or even a long-term contract could also be very supportive for the project.

Additional equity could be sought from venture capital organisations or by creation of a special purpose vehicle to allow investment funds and other financial institutions to participate in the investment. The rates of return and the stability of earnings would be important factors for these financial institutions.

The perceived risks and the likely rate of return that could be earned on the investment will determine the level of interest of external investors, especially for equity participants. Once the equity funding has been resolved, the question of debt coverage for the project could be considered. It seems unlikely that the project could be funded solely on a debt basis.

Investigation of the financing routes and serious negotiations with potential MRO participants can only proceed once the outline project has been defined and its economics have to be evaluated.

# 1 : air transport industry forecast

# 1. Air Transport Industry Forecast

## 1.1 Forecast of World Fleet 2005-2035

MSP Solutions has prepared its own economic and aircraft fleet forecasts. This estimates the number of aircraft by category until 2035. The forecast was developed using three steps:

- First a macro economic forecast was developed using "mainstream" assumptions to assess GDP growth.
- Traffic forecasts were then calculated from the macro economic forecasts using income and price elasticity factors.
- Finally an aircraft requirement was calculated, using assumptions on operati ng efficiencies and estimates of fleet composition by category.

The forecast examines fleet numbers worldwide and for European based aircraft. Passenger and cargo types have been calculated separately.

The fleet categories used are as follows:
- 747 or larger – Aircraft over 400 seats. A380 will be in this group.
- Mid size wide body aircraft – Includes A300, A330, A340, A350, B767, B777, B787
- Narrow bodies – Aircraft over 90 seats: B757 and A320, B737 families
- Regional jets – Aircraft below 90 seats

The cargo aircraft are also classified in the same categories.

The results of the forecast were compared with the forecasts published by Airbus and Boeing forecasts. Additionally a sensitivity analysis was prepared using more cautious economic assumptions than those of the mainstream scenario. The results are shown in Appendices 4 and 5.

### Macro Economic Forecast

MSP Solutions used the forecast prepared by the US Department of Energy (DOE). Their figures produced similar GDP results as other forecasts such as those of the IMF, but importantly they included an estimate of oil prices, which is crucial to an air transport forecast.

The DOE forecast only looked as far as 2025, so the ensuing 10-year figures were extrapolated. The mainstream forecast shows the global GDP growth slowing during the period from 4.0% to 3.5%, compared with an average of 4.3% for the period 2001-2005. European growth slows from 2.5% to 2.2%.

Of the manufacturers, only Boeing showed the GDP forecast. They used an average growth rate of 2.9%, which seems fairly cautious.

The DOE oil price forecast expects a 6.6% annual reduction in real terms until 2010, followed by an annual increase of 0.8%. This in effect makes the assumption that the oil price rises experienced during 2005 were a short-term phenomenon. This issue is considered further in the sensitivity analysis.

### Traffic Growth

Traffic growth is in large part driven by GDP growths, with elasticity varying in economies at different stages of their development. Price is also an important factor.

Passenger traffic has grown at an average of 4.6% per annum since 1985, while European growth has increased at 5.7% per annum. The higher figure for Europe reflects the stimulation effect of low prices, especially a consequence of the rapid expansion of low cost carriers. It should also be noted that the worldwide growth rate has proved remarkably consistent over the long term, with short-term falls, as occurred in 2002, being quickly recovered within a few years.

Forecasts for passenger growth are as follows.

| | *Airbus* | *Boeing* | *MSP Solutions* | |
|---|---|---|---|---|
| | | | *World* | *Europe* |
| *2005-2015* | *6.0%* | *5.3%* | *5.8%* | *4.1%* |
| *2015-2025* | *4.6%* | *4.3%* | *4.7%* | *3.2%* |
| *2025-2035* | | | *4.5%* | *3.0%* |

The three forecasts are all in a remarkably similar range, though it should be noted that the first period 2005-2015 is above the long-term trend. This is not entirely surprising given that the fuel price assumption means significant reductions in real terms, which would translate into lower prices and greater traffic stimulation. Additionally the advent of low costs carriers has had the impact of forcing general cost reductions throughout the industry.

It is also assumed that airlines can continue to make other unit cost efficiencies, for example through

higher load factors, higher aircraft utilisation and improved economies of scale through use of larger aircraft. As a result, airfares and cargo rates continue to reduce in real terms by 0.9% per annum over the whole period.

These forecasts all reflect an unconstrained situation, with the assumption that capacity limitations at airports and other infrastructure will not limit growth. Also it assumed that there would be no dramatic change in the underlying economics, for example fuel (as discussed) that other costs do not increase in real terms and that no new aviation tax increases are implemented.

Equivalent forecasts for cargo growth are as follows.

| | *Airbus* | *Boeing* | *MSP Solutions* | |
|---|---|---|---|---|
| | | | *World* | *Europe* |
| *2005-2015* | *5.9%* | *6.2%* | *6.3%* | *4.1%* |
| *2015-2025* | *5.9%* | *6.2%* | *5.5%* | *3.5%* |
| *2025-2035* | | | *5.3%* | *3.4%* |

Again the forecasts are fairly close together. It is also expected that European growth will be lower than the worldwide trend. Generally the prospects for cargo growth are higher than for passenger market.

The following charts show the traffic growth, using the index 2005=100. It will be seen that for the period to 2035, worldwide passenger traffic grows fourfold, worldwide cargo grows five fold while European passenger traffic is a little shy of tripling.

*Figure 1.1*
*Passenger Growth Worldwide*

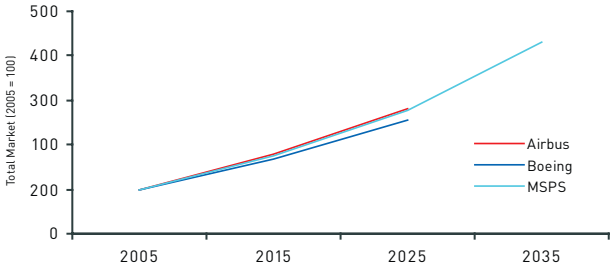



*Figure 1.2*
*Cargo Growth Worldwide*

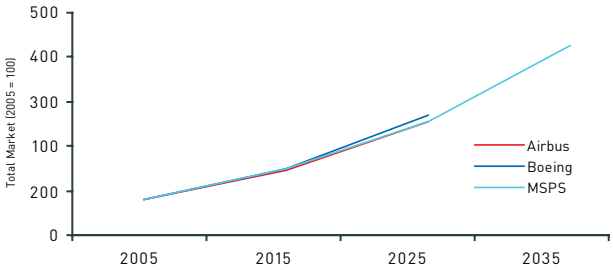
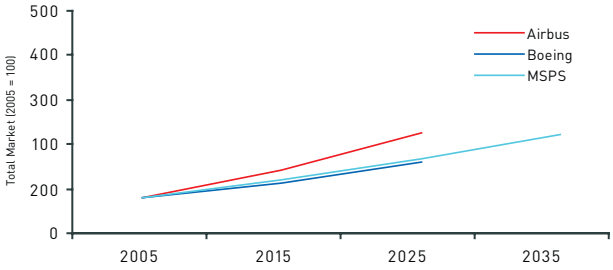



*Figure 1.3*
*Passenger Growth Europe*




**Fleet Size**

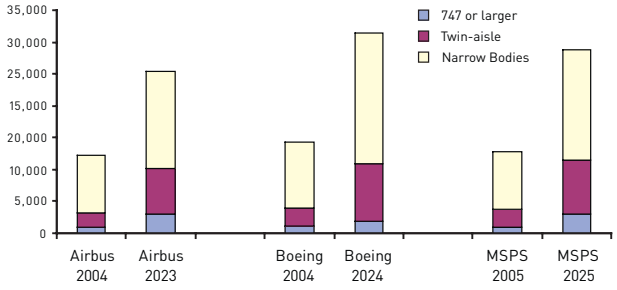
The traffic growth can be used as a basis to estimate the fleet size. This calculation is not straightforward as it is necessary to make assumptions on the average aircraft size. Not surprisingly, Airbus anticipates a larger requirement for large aircraft in the A380 category; while Boeing believes there will be a greater requirement for mid sized aircraft such as the B787 and B777. These conclusions are not entirely surprising given the contrasting strategies of the two manufacturers with Airbus having made a massive stake on the Airbus A380 while Boeing have invested heavily in mid size types B777 and B787.

MSP Solutions believes that there will be a trend towards larger aircraft. Partly this will be forced capacity constraints at major airports such as Heathrow, Gatwick and Frankfurt. Also operating economics favour larger aircraft, especially if market growth can sustain the additional capacity. Thus MSP Solutions believes that Boeing have been unduly pessimistic in their forecast of the 747 or larger category, while Airbus have underestimated the mid size twin aisle aircraft.

The recent announcements of the B747 Advanced and the A350 suggest that both the manufacturers may have had second thoughts about their own forecasts!

The manufacturers' forecasts along with the MSP Solutions assessment are shown in the following chart.

*Figure 1.4*
*Airbus, Boeing & MSP Solutions Fleet Forecasts*




The base figures used by Airbus are lower than those used by Boeing – this appears to be because they have excluded stored aircraft – MSP Solutions has followed the same approach as Airbus, though the base line date is later.

The figures shown above include passenger and cargo aircraft above 90 seat capacity but exclude CIS (principally Russian and Ukrainian) built aircraft. MSP Solutions has also included regional jets in their total calculations, as has Boeing. It should be noted that Airbus excludes estimates of regional jets in its published forecasts.

The next two charts show the MSP Solutions fleet forecast through the period to 2035. The global fleet is expected to roughly triple from 15,000 to 44,000 and the European fleet will nearly double from 3,600 to 6,500. In spite of the shift towards larger aircraft, more than half of the aircraft in service in 2035 will be narrow bodies.

*Figure 1.5*
*Total Worldwide Fleet*

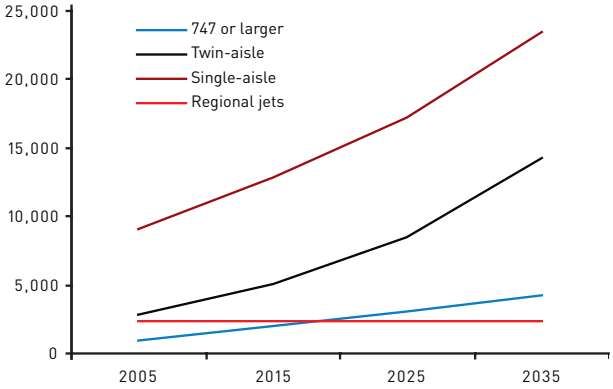
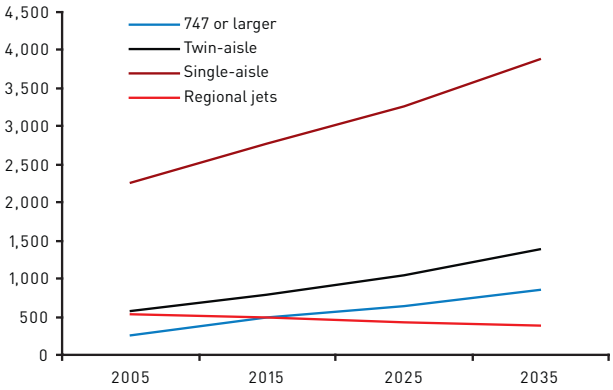



*Figure 1.6*
*Total European Fleet*




## 1.2 Sensitivity Analysis

MSP Solutions has looked at a forecast based on more pessimistic macro economic assumptions.

As a first step the DOE alternative forecast based on higher oil prices was examined. Even this forecast seemed rather optimistic, as the oil price is assumed to decrease by 3.4% in each of the first 5 years. This now seems much less likely – the DOE forecast was published in July – given the price remaining at around $60 per barrel.

It is the MSP Solutions view that there is a strong possibility that the price will remain high, especially as the increase has been caused by buoyant demand rather than artificially applied supply restrictions, as has occurred with previous price surges.

For the purposes of a deliberately cautious forecast, MSP Solutions has recalculated the forecast based on an oil price increasing each year at 2.5% in real terms. This has the effect of reducing GDP and also has a significant impact on airline costs, which would have to be reflected in airfares and cargo rates.

Although the oil price assumption is very pessimistic compared with the mainstream forecast, the effect is not as devastating as might be expected. The GDP growth rate does indeed decline - to an average of 2.2% for the period 2005 to 2035 (compared with 3.7% in the mainstream forecast). It also means that fares increase in real terms but only by an average 0.04% per annum. (In passing, it is worth noting that both the world economy and the airline industry have been remarkably resilient in absorbing the recent oil price rise of over 40% year on year.)

As a result of these more cautious assumptions, the growth rates are roughly a half of the mainstream forecast. Nevertheless air traffic still manages to double by 2035 and fleet size increases to nearly 24,000, a growth of 60%. Full results are shown in Appendix 5.

## 1.3 MRO Prospects

The forecasts demonstrate that the total fleet will continue to grow over the period, even in the alternative scenario used in the sensitivity analysis. However this does not necessarily translate into a growth in MRO requirements and facilities. With continual improvements in design and production techniques, each succeeding generation of aircraft requires less maintenance than the predecessor. This is demonstrated by the table in Appendix 1, which shows that the B737 New Generation aircraft require roughly half the scheduled man-hours as the predecessor classic B737 types.

Higher fuel prices will in fact accentuate this trend. Whereas the current average life of an aircraft is 25 years, the older types will in future be retired earlier as modern replacements offer better fuel efficiency. There are already signs that retirement ages are reducing and it is possible that the average lifespan could reduce to 20 or even 15 years. Though this is encouraging news for the manufacturers, it is not so for the MRO suppliers!

# 2 : characteristics of the mro market

# 2. Characteristics of the MRO Market

## 2.1 Key Segments of MRO

The key segments of maintenance, repair and overhaul (MRO) activity are as follows:

- Line Maintenance
- Airframe Heavy Maintenance
- Engine Overhaul
- Components Overhaul
- Modifications

**Line Maintenance:**

This is the activity associated with routine turning round and servicing aircraft up to and including A Checks. It is an activity very largely done in-house by the legacy airlines (flag carriers and full-service airlines) either for themselves or for their partners. They frequently club together their needs especially for common aircraft types and one airline provides the engineering service for all the participating airlines. Many new entrant airlines, especially where they have low frequencies to particular cities, subcontract out this work. This situation is particularly common at outstations.

Most of the cost of routine line maintenance is labour costs. Typically it now accounts for about 85% of the total costs. However, over recent years there has been a significant reduction in the labour content and hence cost savings in selected areas by possibly up to 30%. Examples include the routine ground turnaround of aircraft without an engineer and contracting the supervision of aircraft fuelling operations out to the oil companies supplying the airline at the individual airports where it operates.

**Airframe Heavy Maintenance:**

• In airframe heavy maintenance, approximately 85% of the total cost is for labour with only a small element for materials.

The introduction of the latest generation of aircraft is having a very significant affect on overall workloads. Service intervals and types of maintenance change as new aircraft types are introduced into service. Generally the newer aircraft types have increasing longer time and/or cycles before overhaul is required. The manufacturers are also extending the service intervals as they build up experience of the reliability profiles of the different aircraft types.

Appendix 1 shows an example of the maintenance requirements of the B737 new generation and of the predecessor "classic" type.

**Engine Overhaul:**

This is essentially a material intensive process with labour only accounting for 15-20% of total cost. The OEMs control about 45% of the work with the airlines doing around 35% in-house. This then leaves the remainder (20%) split fairly evenly between airline third party contracts and independent sources. The engine manufacturers have increasing sought to raise their share of the engine overhaul market as it is a valuable source of substantial additional revenue and profit.

Engine overhaul work is of a highly technical nature and large elements of it call for highly specialised equipment and tooling. Since materials make up such a large element of the total cost, and because there is considerable effort put into the restoration of items through sophisticated technical processes such as plasma spray, it gives a natural advantage for the engine manufacturers to carry out the work.

While some airlines' MRO divisions, for example Lufthansa Technik, carry out a substantial amount of engine overhaul, it is doubtful whether this is as profitable for them as it would be for the engine manufacturers to carry out the work.

The engine repair OEMs are also able to offer the smaller airlines the benefit of purchasing engines on a pay-as-you-go basis per flying hour. This is called Power by the Hour. Some low-cost airlines operate on this basis but at discounted rates from the OEMs.

Performance retention is a key part of jet engine engineering. Over the past 15 years there has been a massive improvement jet engine performance retention that has had an effect of reducing the average level of engine maintenance per operating hour. At the same time the number of engines has grown significantly as the aircraft fleet has increased.

**Components:**

The largest share of this activity is carried out by the original equipment manufacturer (OEM). They have an advantage with technical knowledge of new products. Techniques and tools developed for the manufacturing process can readily be adapted for

maintenance tasks. In addition, it is becoming increasingly beneficial for an airline operator to leave all the work to the OEM, who has the advantage of much larger scale of activity. Contracting-out this work to OEMs also saves the costs associated with procuring spare parts and tooling for a smaller number of items by the airline.

Additionally, for reasons of simplicity there is tendency to transfer the ownership of inventory to the OEM or other repair agency and base charges on a per flight hour basis.

**Modifications:**

Modification work is so varied that no single factor accounts for a predominant amount. Some modifications such as conversion work of passenger aircraft to cargo involves complexity and is expensive. The aircraft manufacturers have approved conversion processes, parts and procedures and tend to limit the number of MROs that they will licence to carry out this work. This tight control also maintains profitability of this process for the OEMs. Carrying out of passenger product modifications (interiors and in-flight entertainment systems IFE) is also expensive and quite labour intensive.

Additionally, there is an element associated with mandatory changes to service bulletins. Increasingly, some of the more established MROs are expanding to take on large amounts of this work in purpose-built facilities.

## 2.2 Contracts in Use

There are a number of differing types of contractual arrangement that operators make with MRO suppliers. These are described below:

• One-off contracts for the defined work package
Normally this would be done on a fixed price for the scheduled work with additional work being at an agreed man-hour rate per item. Difficulties invariably arise when the final bill comes in with frequent major disputes over the level of booked hours! In addition, the customer usually has to provide a number of engineers to be on site in order to agree what the scope of the additional work is to be and to act as a technical monitor of the work as it progresses.

• Long-term contracts to cover a whole fleet over a fixed time period
Often this will be for a number of years. As a result of the certainty of an income stream for the supplier, the overall price will fall and a better relationship will develop.

• Power by the Hour
This is a concept whereby the supplier is effectively selling a total service to the customer. Often used in the engine market, it guarantees the availability of serviceable engines in exchange for a fixed price per actual flying hour achieved. Airline finance directors particularly support this type of arrangement, as it gives fixed and predictable costs over the life of the contract. Additionally, it encourages the improvement of quality, since the longer the engine stays in service the lower the cost to the supplier. This type of contract is now being used increasingly for the component industry.
A variation of this type of support is where the supplier takes ownership of the entire inventory of the customer and manages it on his behalf. A typical inventory might be 7 -10 % of the initial aircraft purchase price so the savings for the customer can be very great.

• Total Maintenance
This is an increasingly popular contract for the emerging airlines. The MRO supplier contacts to support the total operation from the departure phase all the way through to major maintenance including parts. Contracts of this type are necessarily long so giving both the customer and the supplier some stability in revenues and costs.

## 2.3 Work Loads

All maintenance tasks are generated as a result of the aircraft operation. The manufacturer, in conjunction with the regulator (CAA in the UK and the FAA in the USA), produces a Maintenance Planning

Document (MPD) for the particular aircraft type. This spells out the required task and the frequency – or interval – at which individual maintenance checks have to be undertaken. This is normally a function of flying hours; landings; cycles and calendar time. In some cases several of these parameters may simultaneously apply and the first hurdle in any category triggers the requirement for a maintenance check or overhaul requirement.

The operator may vary these intervals, in conjunction with the regulator and manufacturer, to suit his particular type of operation. For example an operator with a predominantly summer operation may wish to confine his maintenance to the winter months.

Engine maintenance is defined by the number of hours of operation and by the operating cycles – this being necessary since the number of take-offs affects the stress and thus the wear on the engine. The scope of work actually needed at engine removal is not fixed and will depend to a large degree on the engine condition at removal and the requirements of the operator in terms of its next planned removal.

Component maintenance is increasingly dictated by failure rather than by a fixed life, except where any failure could adversely affect safety.

It is clear from the above that the projected growth in fleets and traffic will generate additional work for the maintainers. However, there are already significant technology improvements in place and more undoubtedly planned. Evidence shows that the traffic growth will not produce a similarly sized growth in work load. Indeed, due to technological change our forecast shows a possible reduction overall.

Technology changes have been accompanied with improvements in productivity. The traditional way in which work was divided up between trades has changed in a major way. It is now quite common for a single trade group to carry out all the functions and indeed for most individuals to certify their own work. Previously, certification was carried out by specialist staff or by a limited number of skilled tradesmen.

Finally, in this area, the role of the Trades Unions has also changed. Traditionally they were opposed to any transfer of work out of the operators' own facilities. Now transfers and sub contracting are commonplace with changes being negotiated.

In all the above the key is costs. Not only is the direct cost of the work important, but also the overall cost of the maintenance task as a percentage of total cost for the operator is a determinant. Since the major success factor for any airline is the amount of flying they can get out of an aircraft, it follows that the maintenance needs to be done in such a way that downtime is minimised. It is perfectly legitimate for actual maintenance costs to rise if there is a trade-off in terms of reduced downtime.

The chart in Appendix 1 shows the typical intervals and man-hours planned for B737 by one of the European maintainers. Variations between new and older generation aircraft are clearly evident.

## 2.4 Capacity

This is normally measured – for airframe maintenance – in terms of available man-hours. The calculations needed are relatively simple but have a profound affect on both costs and productivity. While costs are driven directly by paid man-hours the efficiency of a unit is driven by available man-hours and by the rate of utilisation of those hours. So, while all the employees contracted hours are paid, he –or she – is only useful when actually at work and actually working!

These issues have significantly affected the planning and execution of tasks with heavy emphasis placed on production planning and computer aided task allocation.

The challenge for maintainers is to have just enough capacity for the contracted tasks but not too much which stands around unused.

Our clear impression of the UK market at present is one of some excess capacity although this appears to be localised and may be a feature of only some MRO facilities. There are definitely excess physical facilities but these are in the main on valuable land. The Eastern European market appears, by contrast, to be capacity constrained. There may be an opportunity here to develop contracts into the future.

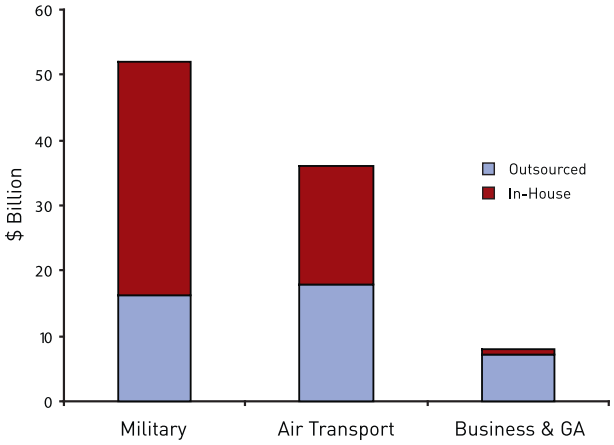
# 3 : survey of the mro suppliers

# 3. Survey of MRO Suppliers

## 3.1 Size of the MRO market

The following chart demonstrates that nearly $100 billion is spent annually on aircraft MRO. This is more than the value of new aircraft production that is estimated at about $75 billion.

*Figure 3.1*
*2004 Global Aircraft MRO Spending*




The total includes military spending is the largest proportion of MRO activity. However, the largest share of the military spend will be American and this may not be available for international tender. Also it should be noted that it is not practical to mix military and civil aircraft maintenance and repair activities as the methods, constraints and priorities are very different. MRO suppliers that are involved in both sectors tend to keep military and civilian activity in separate lines or even as separate business units.

The air transport portion of the MRO business is estimated to be worth over $36 billion worldwide, of which 50% is outsourced to third party suppliers.

The next chart shows the worldwide split of the air transport MRO market by segment. Engine overhaul is the largest segment, with the remainder split roughly equally between line maintenance, component overhaul and the combination of airframe heavy maintenance and modifications.

*Figure 3.2*
*MRO Segments %*

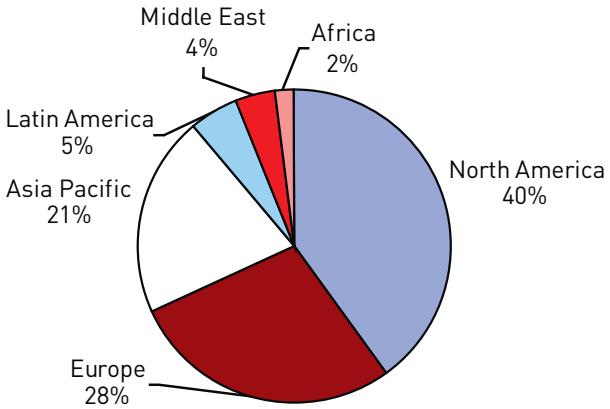
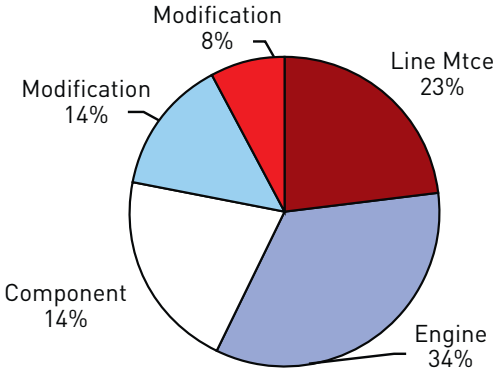



*Figure 3.3*
*Global Shares*




The final chart in this section shows the distribution of air transport MRO activity by region.

North America is the largest market followed by the European market, which represents 28% of the total global spend and is worth $10 billion per annum.

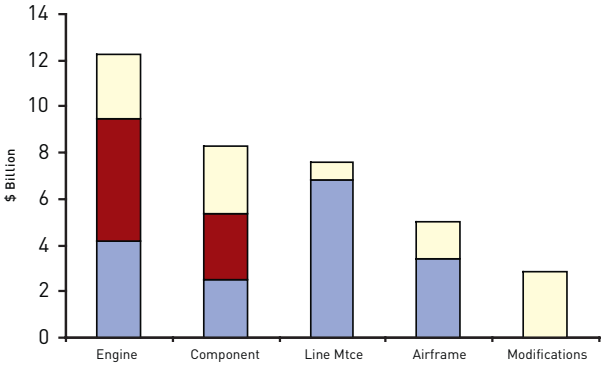
## 3.2 Types of MRO Supplier

There are three types of supplier

- Third party contractors, either specialist MRO providers or airlines supplying on a third party basis
- Original Equipment Manufacturer (OEM)
- In house by the airline operator itself

The split between these categories varies according to the element of MRO activity, as is shown in the following chart.

*Figure 3.4*
*Global MRO Segments by Supplier Type*




Large proportions of engine and components overhaul are carried out by the manufacturers (43% and 35% respectively). Independent third party suppliers have the largest share of airframe heavy maintenance and modifications. Indeed modification activity is largely in the hands of the third party suppliers.

In Europe there has been a tradition that the main national airlines kept as much possible of their maintenance in-house. However recent years have seen an increasing trend towards outsourcing. In some cases this has meant placing a high proportion of MRO activity with completely independent suppliers. Other major airlines have set up their MRO operations as profit centre businesses within their group: Lufthansa Technik and Air France Industries (AFI) are examples of major MRO supplier which began life as an in-house engineering department but which has grown into a major third party supplier. SR Technics is another interesting case: it become a separate company within the Swissair group and eventually outlived its parent to become totally a third party supplier.

Over recent years a number of airlines have contracted out engine overhaul or sold their engine overhaul workshops to the engine manufacturers. For example British Airways sold its Treforest works in South Wales to General Electric of the USA (GE) and has let large contracts to both GE and Rolls-Royce (RR) for engine overhaul and the supply of spare engines.

Given that aircraft can move easily from one region to another, suppliers are competing on an international, if not global basis. For example European airlines already despatch aircraft to engineering facilities in Asia for some tasks, especially modifications and D checks. This is worthwhile because manpower costs are lower and quality is good. However, the scope for such solutions is constrained because the time taken to ferry aircraft to and from Asia is a major factor as it means a loss of revenue earning days.

MRO are suppliers in Eastern Europe are making an attempt to expand their markets, using the advantage of lower labour costs. There have been concerns about the quality and reliability (in terms of scheduled downtime) of some of the suppliers. Additionally there are signs that these facilities are already becoming capacity constrained.

Suppliers in Israel however have also managed to make an impact. Labour costs are also low, but quality and reliability are good.

## 3.3 Existing MRO Facilities

The total MRO market is vast and situated in all five continents with over 300 suppliers in total.

This section of the study will focus primarily of the facilities in Western Europe, as this is the arena within which a Glasgow MRO would have to operate. The study will also examine MRO facilities in Israel, where there are a number of competitive suppliers within reasonable geographical range of the European market.

### MRO Facilities in the UK

The following is a summary MRO activity in the UK. A number of significant airlines are not mentioned, including easyJet, Virgin Atlantic and Thomson Fly (formerly Britannia), as they rely mainly on third party providers for their maintenance support.

• British Airways
As the major operator in the UK and with one of the largest engineering facilities in Europe, they obviously need to be considered. They have traditionally done all their own work in-house and they now perform no third party work.
In the late 1980s they sold off their Engine Division to GE and reached a 10-year contract with them for all their existing engine work. Latterly this relationship has been strengthened by a new 10-year renewal of the contract for all the RR RB211 and GE engine types (GE90 and CFM 56). It is believed that Rolls-Royce maintains the RR Trents on the RR powered B777 fleet.
They have also split off their workshop and component overhaul units to subsidiary companies and relocated them away from Heathrow. In some cases they have sub contracted specific tasks – such as wheel, brake and undercarriage overhaul – to outside companies.
They have greatly reduced both their work loads and workforce by progressively implementing productivity agreements and working with the manufacturers to improve maintenance practices.

• BMI
The main bases are at Heathrow and East Midlands. Besides maintaining its own fleet, BMI perform heavy maintenance up to C check for Virgin Atlantic.

• Rolls-Royce plc Aero Repair & Overhaul
Part of the aero engine business, Rolls-Royce has four UK facilities. Rolls-Royce Aero specialises in engine refurbishment and overhaul for a large customer base including civil, military and marine applications. It also has a comprehensive parts refurbishment capability. Rolls-Royce has associated companies worldwide, including facilities in the USA and Canada.

• Marshall Aerospace
Marshall is based at Cambridge and specialises in design, development, maintenance and conversion of military, civil, business and general aviation aircraft. Boeing and Airbus aircraft are services up to D check level. Marshall Aerospace is also a major maintenance supplier for military aircraft. Additionally, they perform a significant amount of manufacturing work for aircraft manufacturers. They have facilities for total airframe maintenance for all sizes of aircraft up to and including the B747.

• Bournemouth Aviation Services (BASCO)
BASCO is now owned by Singapore Technologies Aerospace. They specialise in aircraft maintenance and modifications especially on widebody aircraft.

• ATC Lasham Ltd
ATC Lasham was originally part of the charter airline Dan Air. They are now significant suppliers to operators and individual owners of executive jets. Originally based at Lasham, they have recently acquired the premises of the former Heavylift Company at Southend where they plan to open an A320/321 maintenance facility. In addition they have taken over hangar facilities at Cardiff previously used by DARA and plan to open a B757/767 Maintenance Line

• Monarch
The main base is at Luton, maintaining its own aircraft and providing third party services.

MRO Facilities in Continental Europe
The main MRO suppliers in Europe have developed from airline in-house operations. The most significant exception is EADS. The following is a summary of some key players.

• Lufthansa Technik
Part of the Lufthansa group, Lufthansa Technik is the largest MRO provider in Europe with total staff of 16,000. It provides MRO services for all major commercial aircraft and provides maintenance support at over 60 international airports.
Lufthansa Technik was formed from the Engineering Division of Lufthansa at a time when the main national carriers were reviewing their cost bases and organisations. The intent was to allow more freedom for the carrier to choose its supplier but, more importantly, to ensure that the Engineering division was aware of its true costs and thus to more likely to run its activities on more business like terms.
Lufthansa Technik has become highly successful and has rapidly expanded both in and outside Europe. Significantly it has set up a joint venture with Malev in Budapest (in which it holds 85%) and another partnership with Air Malta. It has also acquired Shannon Aerospace in Ireland. In a recent move, they have formed a further partnership with Garuda in Indonesia. These companies are clearly intended to provide capacity and services at lower cost than the main bases at Hamburg and Frankfurt.

• Air France Industries (AFI)
AFI is the next largest MRO supplier in Europe, with 11,000 employees. Originally the Engineering Division of Air France, AFI now operate as an autonomous unit within the parent organisation. They have

been very active in the Component Support area offering total Inventory Management. They also undertake the full range of Airframe maintenance. It is believed that about 80% of their work is now for third parties.

• EADS

The majority owner of Airbus, EADS has developed a large presence in the MRO market through various subsidiaries. Not surprisingly the company specialises in supporting Airbus aircraft.

The main subsidiary company is Sogerma. Its headquarters is in Bordeaux and has a number of bases in France and also in Tunisia and Morocco. They undertake a total range of engine, airframe and component services. Currently EADS has over 500 customers and a staff in excess of 4,000. Other divisions include ASLLC at Lake Charles in Louisiana, Barfield at Miami, EFW at Dresden in Germany and EADS Revima in France.

• SR Technics

SR Technics, once the Engineering Division of Swissair it has, unusually, survived the demise of its parent. It is very successful and has recently bought up FLS with bases at Stansted, Manchester and Dublin. SR Technics offer a full range of services and have recently concluded a £10m per year deal with easyJet for total support of their fleets.

MRO Facilities in Israel

Mention should be made of Israeli suppliers. The main MRO suppliers in Israel are able to offer lower man-hour rates, have established a good reputation for quality, and are not so far distant from Europe as to significantly penalise the time aircraft are out of service. Consequently they are a highly competitive force in the MRO market.

• El AL Tech

The technical organisation of the international airline, EL Al Tech specialises in Boeing aircraft up to D checks and provides logistical support, engineering support and modifications. It is prepared to develop tailor made solutions for its clients.

• IAI Bedek

An independent third party MRO supplier, IAI Bedek can provide airframe, engine, component maintenance and modifications for Boeing and Airbus aircraft. They also perform cargo conversions for Boeing 747, 757 and MD11 aircraft.

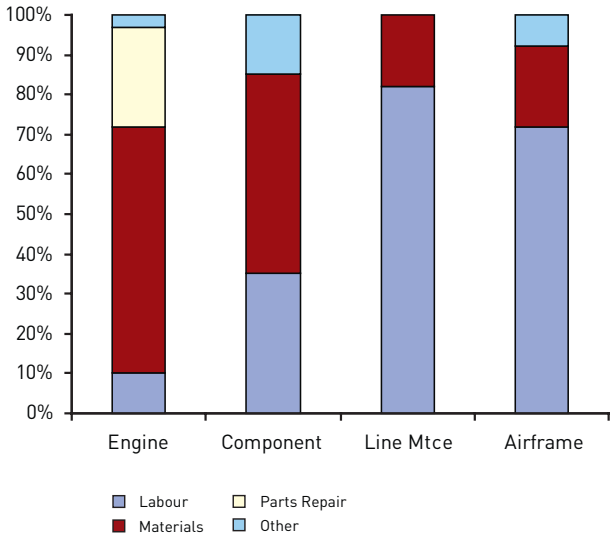
## 3.4 Cost Structure

The following chart shows a breakdown of the costs for each MRO segment. For Line maintenance and for airframe heavy engineering, labour is by far the largest proportion of the cost.

### Financial Performance

The financial performance of some of the UK MROs has been giving concern for some time. Prior to its absorption by SR Technics, the Stansted based MRO FLS was reported to be heavily loss-making. BASCO is now part of Singapore Technologies Aerospace also was reported as loss-making in 2004.

*Figure 3.5*
*MRO Expenditure by Catagory %*



# 4 : mro opportunities at glasgow



(Please note this section is specific to Glasgow Airport and would not apply to the other Strair Partners' airports.)

# 4. MRO Opportunities at Glasgow

## 4.1 Introduction

This section of the report considers the specific challenges which the sponsors face in developing an MRO facility at Glasgow Airport.

First of all the barriers to entry are described along with the key parameters which will determine success.

As a key part of the exercise a number of interviews were held with senior managers from a selection of airlines and MRO suppliers. These interviews were extremely helpful in establishing the viewpoints of the type of the organisations that will be vital to the development of MRO activities.

On the basis of the analysis, MSP Solutions has concluded the report with some recommendations that need to be addressed if the Sponsors are to be successful in attracting MRO activity to Glasgow.

## 4.2 Barriers to MRO Entry

**Premises**
All types of MRO activities requires premises for their work. These naturally vary depending on the range of tasks and the aircraft types being handled. Most suppliers, particularly the more established ones, tend to own their facilities outright although the land may be on long-term lease.

**Labour**
The aircraft side of the business is the most demanding in terms of labour and of qualified staff who can certify their work and that of others. Since the completion of work in a timely fashion is critical to the success of the business, this naturally means a significant level of labour as well. It is fairly common to see up to 1,000 man-hours per day made available spread over a 7-day double day shift pattern. Using the normal figures for the Industry of some 1,500 hours per man per year this would equate to some 250 employees PER LINE. Big numbers!

In the engine business, where labour cost is less than material costs, the labour issue is not so great. Additionally, much of the work is process driven and requires more specific skills but over a limited range. Component work involves a lot of automatic testing as well as more detailed assembly. Numbers tend to be lower here.

**Tooling & Support Equipment.**
The investment levels for aircraft maintenance are fairly low being generally confined to support rigs and specific tooling. For engine work the provision of specialist machinery and metal treatment systems add considerably to cost, as does the provision for engine testing. A recent engine cell for a high bypass engine was installed to in excess of $5M.

**Capital Investment**
All the above obviously require capital investment in the first instance. When the current state of the Industry is taken into account, it is easy to see why there is some reluctance to invest in new facilities. A number of providers have been reporting significant losses over the last several years, as have their customers. There is a major squeeze on costs by the airline operators with traditional costs of 13-15% of total costs falling to some 9-10%.

**Track Record**
It is extremely difficult to get a customer base from scratch. The industry tends to trust existing players rather then brand new entrants. Increasingly we are seeing new companies being floated off from existing ones.

## 4.3 Success Parameters

Any knowledgeable customer will seek to have:

• Guaranteed and minimised downtime. An aircraft has to fly to earn and if it is in a hangar it is not earning. So, downtime has become a critical factor – even above cost – in deciding whom to use as a supplier.
• Quality in the shape of reliability is the next priority. It has become virtually an assumed issue since a long-term failure to deliver this will result in no contracts.
• Price. This only becomes an issue after the two criteria above are met. Most operators will pay more for delivery and quality being achieved.
• Availability. Particularly an issue in the component and engine fields since any aircraft on ground (AOG) occurrence will directly affect revenues.
• Financial success. A positive return on capital as well as an operating profit and a return to shareholders are the more obvious ones. In the current market it is increasingly seen to be gaining an increased market share in the expectation of an improvement in finances for the Industry.

## 4.4 Incentives

The issue of state aid, EU subsidies, direct and other direct or indirect incentives available from governments can be an extremely important issue in the location of major investment projects. At present the Glasgow Airport area qualifies for Regional Selective Assistance (RSA). This enables grants to be claimed for new project investment.

Regional Selective Assistance, or RSA, is a national grant scheme, aimed at encouraging investment and job creation in the areas of Scotland designated for regional state aid under European Union law (the Assisted Areas).

To be considered for assistance, a project must meet the following criteria:

• Location – it must take place in an Assisted Area.
• Jobs – the project must directly create or safeguard jobs. Assistance will not be given where it leads to job losses elsewhere in the Assisted Areas.
• Investment – it must involve an element of capital investment.
• Viability – the project must make commercial sense, and contribute to the national economy.
• Need – the project must need RSA to enable it to proceed as envisaged. RSA can be used to influence the location of a project to Scotland, make projects bigger, better or happen sooner.

• Other funding – the majority of project funding must come from the private sector.

Eligible project costs can include investment in:

• Land and buildings
• Plant and machinery
• Software and intellectual property (IP)


Levels of grant are negotiated individually, and will depend on the scale of the project and the need for assistance. Most grants represent about 15% of project capital expenditure. These grants generally work out between £5,000 and £10,000 per eligible job, with more for higher quality jobs.

For projects involving relatively low levels of capital investment, assistance can be calculated against the first 2 years' salary costs of new project jobs.

RSA is not limited to a single grant, and can be awarded for subsequent expansion project(s).

The European Union have applied new rules from the beginning of 2007. The new assistance regime is designed to direct as much assistance to the new member states, mainly from Eastern Europe to hasten their process of economic convergence. Consequently the opportunities for assistance in Scotland may become more restrictive.

In considering future investment or expansion plans, businesses are able to apply for RSA under the current regime. As RSA applications can cover planned investment and related jobs over a number of years and, irrespective of the changes effective from 1 January 2007, RSA offers issued before then, including those involving capital investment and jobs beyond that date, will be dealt with on the basis of current rules.

The consequence of these changes means that there is a great deal of urgency in preparing for any new project, with it being necessary to have the planning process advanced to a decision point well before the end of the current year.

## 4.5 Interview Process

This section is not available for publication. The confidentiality of the companies who agreed to take part was guaranteed and therefore it is not proposed to publish their comments.

The main concerns in the industry are downtime, quality and cost. There is a lot of interest in finding new solutions, especially by utilising MRO facilities in Asia. Three of the interviewees expressed varying degrees of interest in a Glasgow MRO base while only one of the five dismissed the possibility out of hand.

## 4.6 Conclusions and Next Steps

Given the scale of the market, MSP Solutions believes that a Glasgow MRO facility would be best placed to look for business maintaining narrow body aircraft of European airlines. There may also be some opportunity for smaller wide body aircraft such as B767, B787 and A350. It is unlikely that Glasgow will be able to compete for business servicing the larger wide bodies (A380, B747) as the market size will be smaller and the investment in resources much greater.

The interview process shows that there are companies that would consider using an MRO facility at Glasgow. At this stage, the companies involved wish the discussions to remain confidential, but if the Sponsors wish to develop proposals, a number of target organisations can already be identified.

A new MRO facility must meet the main concerns of the industry, i.e. downtime, quality and cost. It is essential that these concerns are recognised and addressed at all stages of developing a plan and in the implementation.

The suggested steps are:

- Decide on and define clearly the physical area to be released for the MRO facility. In reaching this decision it will be vital that there is adequate room for a 4 bay facility with room for further expansion at a later date (defined outline MRO facility).
- Clarify, and if possible agree with the existing operators at Glasgow, what is to happen to them and the sites they occupy at present. Of particular concern here must be the continuity of current work.
- Attempt to reach a consensus with other maintainers at other Scottish airports that they either relocate or at the least do not attempt to compete directly with Glasgow.
- Assuming that we are correct in our conclusions that no one else is likely to commit to a capital investment for a new facility it is considered advisable to identify a number of potential tenants first.
- Evaluate the costs (capital expenditure on buildings, equipment and infrastructure, working capital to recruit and train the personnel, other pre-operating expenses), income streams representing a realistic earning potential of the defined outline MRO facility.
- Evaluate the economics of outline project taking into account the income streams, costs under a variety of financing options.

• Initiate discussions with a number of banks and venture capital organisations to seek out the most attractive terms likely to be available for a partner based operation.

However, it is the area of financial arrangements that is arguably the biggest challenge. The interview process revealed that the organisations approached by MSP Solutions might be reluctant to invest their own capital in such a project. While it should be possible to partner with one of these organisations at all stages of the development process, it must be borne in mind that they may be seeking what amounts to a turn-key operation. This means that financing of the project may have to be found outside the existing MRO industry.

If the Sponsors wish to ensure that the MRO project moves ahead, it may ultimately be necessary for them to put up some equity capital. The involvement of BAA as a private company would qualify for the EU grant aid, but there might be problems if Scottish Enterprise and Renfrewshire Council as Government Agencies were to take a majority stake (assuming that they were willing and permitted to do so).

Direct participation of British Airways, even if it is in the form of a long term contract with the new proposed MRO facility to overhaul all their narrow body fleet Airbus A320 family (A319/A320/A321), their B737 family (B737-300/400) and possibly their B757-200/B767-300ER fleets (and their eventual replacements either B787 or A350), would also mitigate the perceived risk for other potential investors.

If additional equity were to be required it might be possible to secure this through venture capital organisations such as 3i or similar types of institutions. Another approach might be to create a special purpose vehicle to allow investment funds and other financial institutions such as pension funds to participate in the investment. The rates of return and the stability of earnings would be important factors for the various financial institutions such as pension funds.

The perceived risks and the likely rate of return that could be earned on the investment will determine the level of interest of external investors, especially for equity participants. Once the equity funding has been resolved, the question of debt coverage for the project could be considered. It seems unlikely that the project could be funded solely on a debt basis.
To secure external financing both equity and debt would require a firm long-term contract from a reputable MRO organisation. Investors will want to ensure that the utilisation of the facility will be high and that there is a high chance that they will be paid the agreed rental streams until the capital is repaid. If the participating MRO organisation would be prepared to put some equity into the project then this might ease the way for other investors to put up capital, whether this would be equity or debt.

Before the questions relating to financing are investigated, the outline project needs to be defined and the economics be evaluated. These two steps will be critical to taking the project forward before any further serious discussions are held either with serious potential MRO participants, investors and debt providers.

# glossary

# Glossary

| | |
|---|---|
| AOG | Aircraft on ground |
| CAA | Civil Aviation Authority |
| CAD | Computer aided design |
| CAM | Computer aided manufacture |
| Checks | Progressive maintenance checks ranging in duration from over night to six weeks. |
| DOE | US Department of Energy |
| ETOPS | ETOPS stands for Extended (range) Twin (engine) Operations and covers special rules for operating twin engine aircraft over water or land where there are no readily usable airports for emergency landings. |
| FAA | Federal Aeronautical Agency (USA) |
| GA | General Aviation |
| GDP | Gross Domestic Product |
| IFE | In flight entertainment |
| MPD | Maintenance Planning Document. This spells out required maintenance tasks and the frequency at which they have to be undertaken. |
| MRO | Maintenance, Repair and Overhaul |
| OEM | Original Equipment Manufacturer |
| RSA | Regional Selective Assistance |

# appendices

1. Example of Maintenance Planning Document. Shows frequency and man hour requirements.
2 Global Fleet – Airbus and Boeing Aircraft.
3. Stored Aircraft.
4. Results Summary - Mainstream Scenario.
5. Results Summary - Alternative Scenario.

# Appendix 1
## Example of Maintenance Planning Document.

**B737-300/400/500**

| Item | Frequency | Man hour requirements | | | | |
|---|---|---|---|---|---|---|
| | | Mechanical | Avionic | Others | Total | Comments |
| Preflight | | 3 | | | 3 | |
| Daily | | 7 | 1 | | 8 | |
| Weekly | | 8 | | | 8 | |
| 1A Check | 300hours/300cycles/50days | 42 | | | 42 | |
| 2A Check | 575hours/575cycles/3months | 82 | 4 | | 86 | |
| 4A Check | 1150hours/1150cycles/6months | 138 | 8 | 7 | 153 | |
| 8A Check | 2300hours/2300cycles/12months | 188 | 10 | 11 | 209 | |
| 1C Check | 4600hours/4600cycles/24months | 1385 | 200 | 370 | 1955 | |
| 2C Check | 9200hours/9200cycles/48months | 1550 | 370 | 555 | 2475 | And 1C Items |
| 3C Check | 12800hours/12800cycles/72months | 1385 | 230 | 390 | 2005 | And 1 & 2 C Items |
| | | | | | | |
| Customer Maint Programme | | | | | | |
| Daily | | 2.5 | 1 | 2.5 | 6 | |
| Weekly | | 4.75 | 2.25 | 2.5 | 9.5 | |
| A Check | | 24 | 8.5 | 8.5 | 41 | |
| 2A Check | 575 hours / 3 months | 30 | 18 | 10 | 58 | |
| 3A Check | | 13 | 1 | 9 | 23 | |
| 4A Check | | 30 | 2 | 11 | 43 | |
| 1C Check | | 514 | 90 | 255 | 859 | And all preceding |
| 2C Check | | 655 | 90 | 520 | 1265 | And all preceding |

**B737 - New generation**

| Item | Frequency | Man hour requirements | | | | |
|---|---|---|---|---|---|---|
| | | Mechanical | Avionic | Others | Total | Comments |
| PreFlight | | 1 | | | 1 | |
| Daily | | 2 | | | 2 | |
| 7 days | 150hrs/50cycles | 1 | | | 2 | |
| 40 days | 300/400/500hrs.300cycles | 14 | | | 14 | |
| 60 Days | 600/700/800hrs.400cycles | 11 | | | 11 | |
| 100 days | 100/1250hours.1000cycles | 25 | | | 25 | |
| 8 months | 1600/2000/2500/3000hours | 35 | | | 35 | |
| 12 Months | 12/15/16mths.3500/4000hours.1250/1600 cycles | 65 | | | 65 | |
| 18 Months | 5000.6000hours.2000cycles | 380 | 15 | | 395 | |
| 24 Months | 6500/8000/10000hours.3000cycles | 223 | 5 | | 228 | |

Shows frequency and man hour requirements.

# Appendix 2
## Global Fleet – Airbus and Boeing Aircraft

**Airbus**

| Type | Total Orders | Total delivered | In Service |
|---|---|---|---|
| A318 | 89 | 27 | 27 |
| A319 | 1,138 | 765 | 764 |
| A320 | 2,082 | 1,440 | 1,429 |
| A321 | 457 | 339 | 338 |
| **Narrow Bodies** | **3,766** | **2,571** | **2,558** |
| A300 | 598 | 546 | 416 |
| A310 | 260 | 255 | 232 |
| A330 | 553 | 374 | 371 |
| A340 | 385 | 310 | 307 |
| A350 | 25 | - | - |
| **Mid size** | **1,821** | **1,485** | **1,326** |
| A380 | 149 | | |
| **Large aircraft** | **149** | **-** | **-** |
| **Airbus Total** | **5,736** | **4,056** | **3,884** |

**Boeing**

| Type | Total Orders | Total delivered | In Service |
|---|---|---|---|
| B717 | | 148 | 137 |
| B737 | 462 | 4,930 | 4,114 |
| B757 | | 1,049 | 993 |
| **Narrow Bodies** | **462** | **6,127** | **5,244** |
| B767 | 14 | 932 | 869 |
| B777 | 109 | 532 | 494 |
| B787 | 185 | - | - |
| **Mid size** | **308** | **1,464** | **1,363** |
| B747 | 43 | 1,364 | 990 |
| **Large aircraft** | **43** | **1,364** | **990** |
| Boeing Total | **813** | **8,955** | **7,597** |

## This data is accurate as at the end of September 2005.

It does not cover the entire world fleet of jet aircraft that is nearer to 17,000 in all, including Russian types, regional jets and discontinued models.

Most significant types still in service are the DC9/MD80/MD90 family of which there are approximately 1,000 still in service. The main wide body not included above is the MD11 of which there are over 100 still in service, many as freighters.

The two most significant regional jet manufacturers are Bombardier of Canada and Embraer of Brazil. BAE Systems has withdrawn from manufacturing civil aircraft but over 300 jet aircraft in the 60-90 seat range are still in service.

# Appendix 3
## Stored Aircraft

The standing down of aircraft has been a feature of the industry since the first Gulf War and subsequent financial recessions. Essentially, as airlines became more and more financially unstable and as traffic fell due to a reluctance of people to fly, there were just too many aircraft in the system.

As a consequence a large – up to 2000 at one stage – number of aircraft were "dumped", largely in the Mojave and Arizona deserts in the USA. They were kept useable and as the travel Industry gradually improved many were brought out of retirement. Subsequent major losses in the industry as a whole have resulted in a further tranche of aircraft being taken out of service and again parked in the desert.

It is not possible to determine with absolute accuracy the stood down aircraft numbers by type, but the following charts give the best available data, as at end of July 2005.

Extrapolating the numbers involved, by taking the percentages involved and applying them to the totals produced, gives a rounded up figure of 2,000 aircraft stored, equivalent to 12% of the world fleet. Many of these are older types: so long as the fuel price stays well above the initial figure of $10 a barrel used when justifying their purchase, they are very unlikely to ever fly again. However, some of the more recent large jets may well be converted to freight use and this of itself will result in conversion work for the MRO industry.

*Figure 3.1*
*Aggregate Aircraft Types*

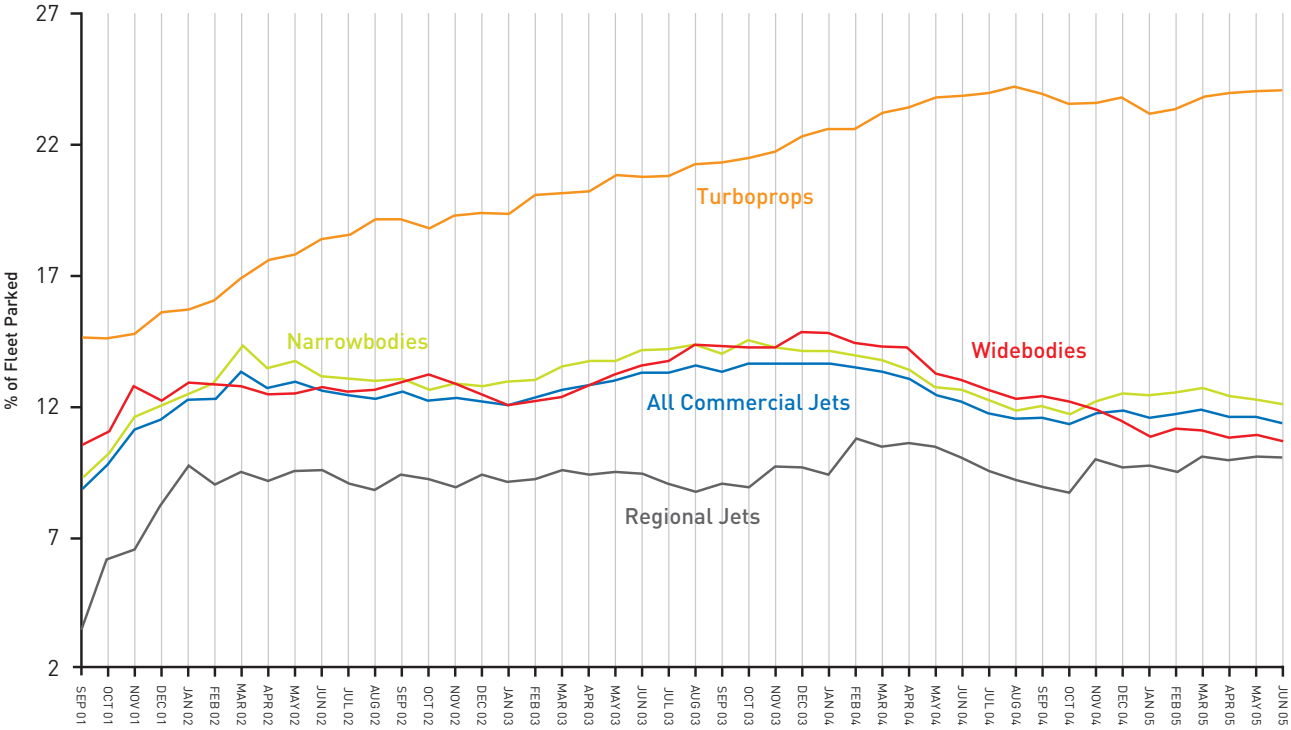


*Figure 3.2*
*Airbus Widebody (twin aisle) aircraft. (Airbus Models: A300, A310, A330 & A340)*

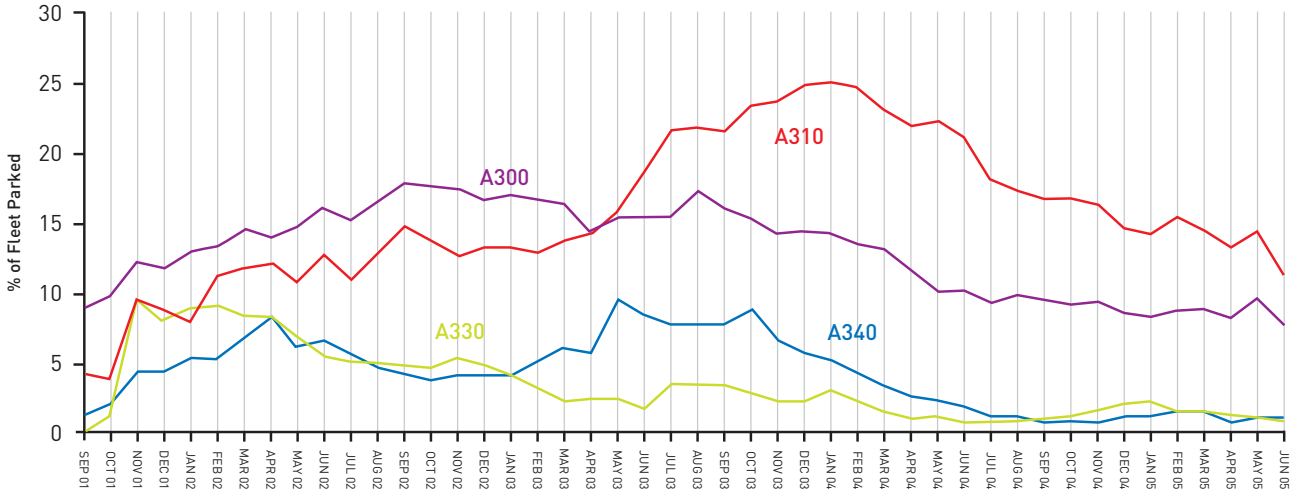



*Figure 3.3*
*Airbus Narrow body (single aisle) aircraft. (Airbus Models: A319. A320-200, A321-200)*

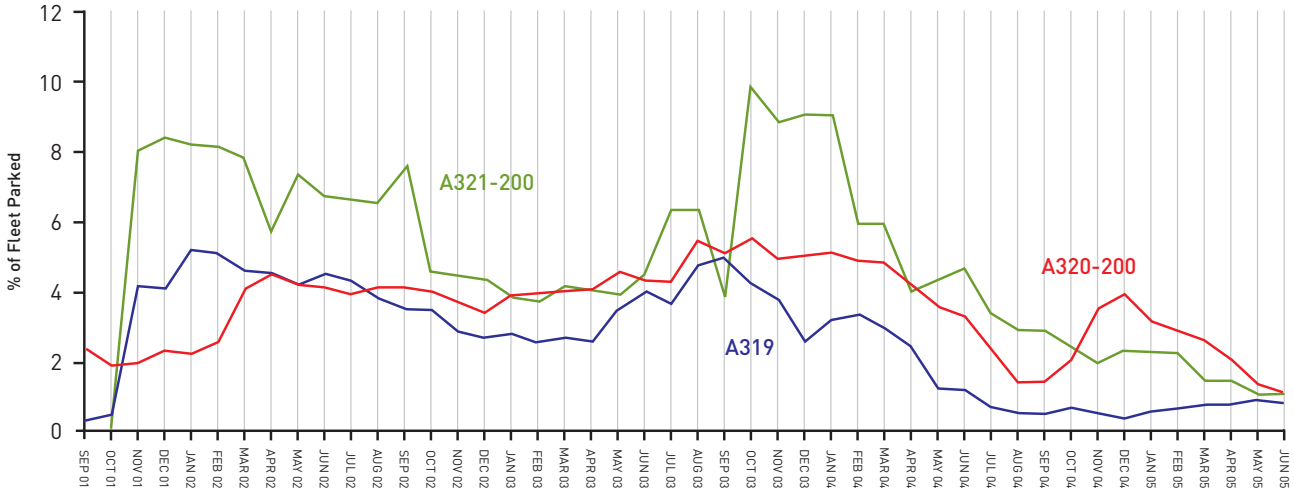



*Figure 3.4*
*Boeing Narrow body (707,717,727) and Widebody (747, 767, 777)*

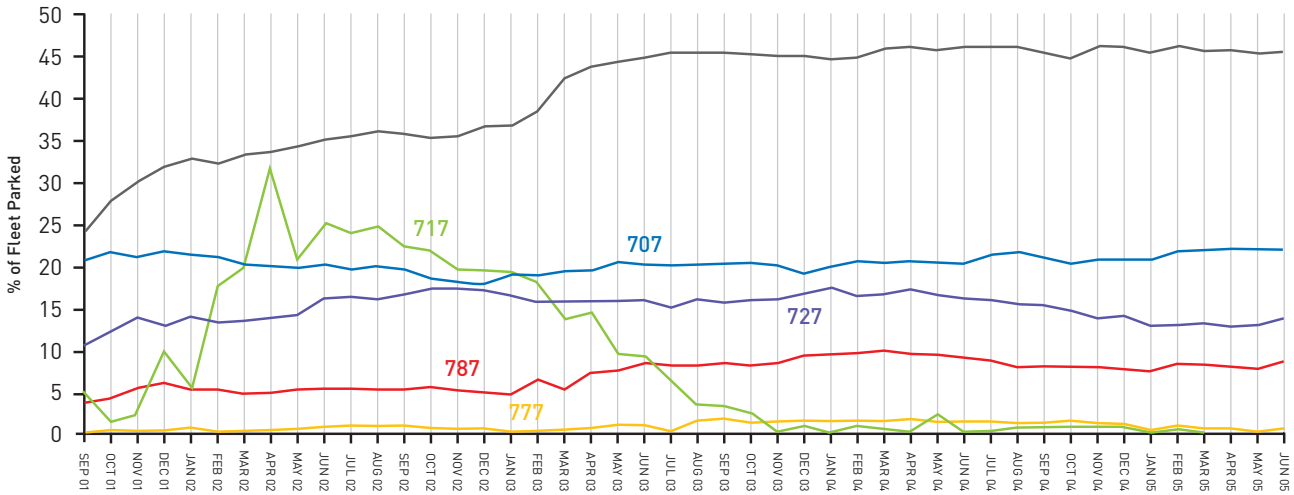


*Figure 3.5*
*Boeing 737 and 757 single aisle aircraft. (Boeing Models: 737-300, 737-400, 737-500, 767-200)*

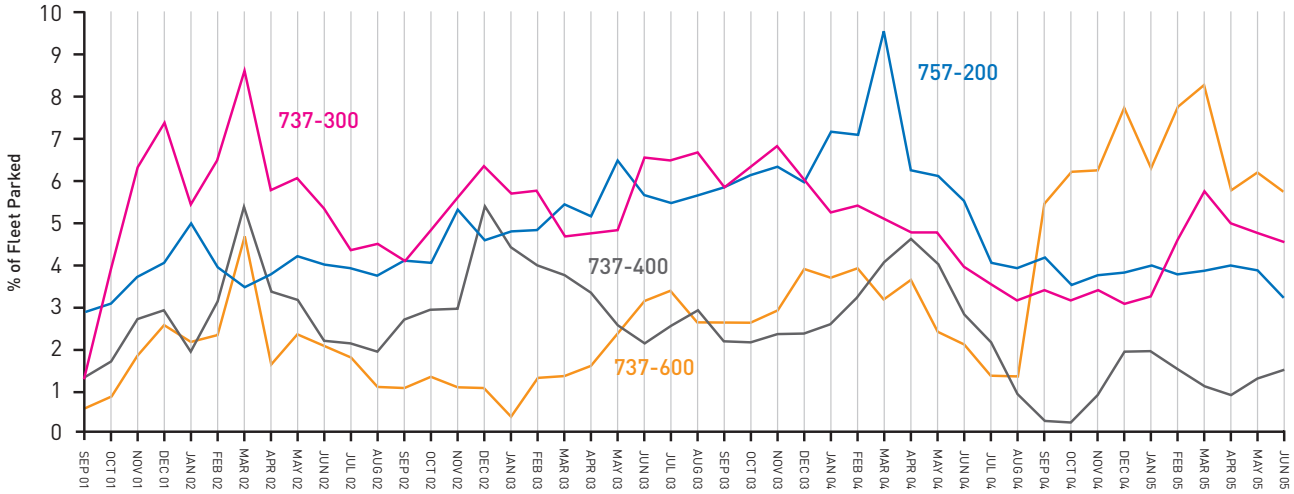



*Figure 3.6*
*McDonnell-Douglas aircraft types now supported by Boeing. (DC10/MD11/MD80)*

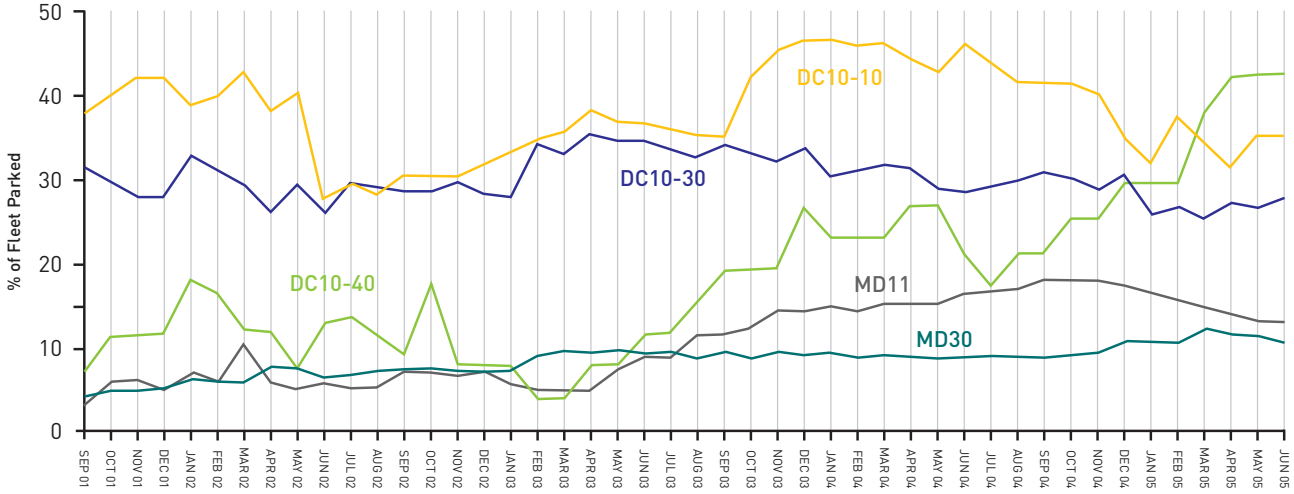
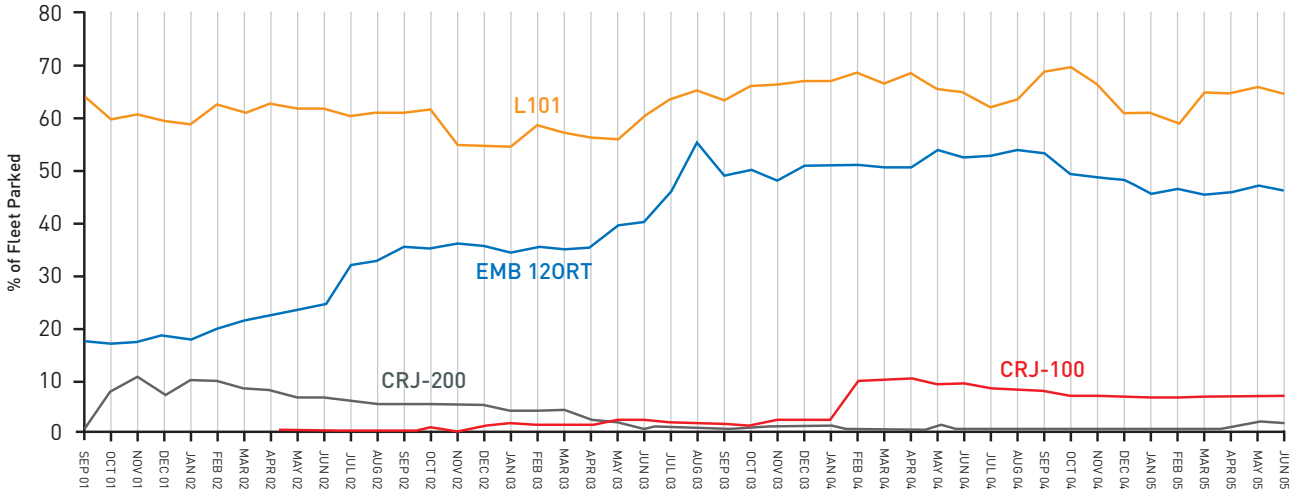



*Figure 3.7*
*Lockheed Tristars (L1011) widebody aircraft and Regional Jets. (CRJ/120RT/L1011)*



# Appendix 4
## Results Summary - Mainstream Scenario

| | | | | Projections | | | | Av growth |
|---|---|---|---|---|---|---|---|---|
| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2005-2035 |
| **GDP** | | | | | | | | |
| World (2005=100) | 100 | 121.9 | 147.1 | 176.2 | 210.0 | 249.1 | 296.4 | |
| Annual % variation | 4.3% | 4.0% | 3.8% | 3.7% | 3.6% | 3.5% | 3.5% | 3.7% |
| Europe (2005=100) | 100 | 113.0 | 126.9 | 142.1 | 158.7 | 176.5 | 196.5 | |
| annual % variation | 2.4% | 2.5% | 2.3% | 2.3% | 2.2% | 2.2% | 2.2% | 2.3% |
| **WORLD OIL PRICES (4)** | | | | | | | | |
| Price per barrel | $51.87 | $36.85 | $38.44 | $40.03 | $41.61 | $43.39 | $45.18 | |
| Index (2005 = 100) | 100 | 71.1 | 74.1 | 77.2 | 80.2 | 83.7 | 87.1 | |
| Annual % variation | 41.1% | -6.6% | 0.8% | 0.8% | 0.8% | 0.8% | 0.8% | -0.5% |
| **AIR FARES** | | | | | | | | |
| Index (2005 = 100) | 100 | 90.3 | 87.2 | 84.2 | 81.5 | 79.0 | 76.6 | |
| Annual % variation | | -2.0% | -0.7% | -0.7% | -0.7% | -0.6% | -0.6% | -0.9% |
| **Passenger traffic forecast** | | | | | | | | |
| World (2005 = 100) | 100 | 137.7 | 175.3 | 221.3 | 277.6 | 345.7 | 431.4 | |
| Annual average % growth | | 6.6% | 4.9% | 4.8% | 4.6% | 4.5% | 4.5% | 5.0% |
| Europe (2005=100) | 100 | 126.6 | 149.0 | 174.7 | 204.0 | 236.6 | 274.5 | |
| Annual average % growth | | 4.8% | 3.3% | 3.2% | 3.1% | 3.0% | 3.0% | 3.4% |
| **Cargo traffic forecast** | | | | | | | | |
| World (2005 = 100) | 100 | 138.9 | 183.8 | 240.7 | 313.1 | 403.9 | 523.1 | |
| Annual average % growth | | 6.8% | 5.8% | 5.5% | 5.4% | 5.2% | 5.3% | 5.7% |
| Europe (2005=100) | 100 | 124.8 | 149.4 | 178.2 | 211.5 | 249.3 | 294.2 | |
| Annual average % growth | | 4.5% | 3.7% | 3.6% | 3.5% | 3.3% | 3.4% | 3.7% |
| **Fleet Forecast (World)** | | | | | | | | |
| 747 or larger | 960 | | 2,053 | | 3,046 | | 4,276 | |
| Twin-aisle | 2,800 | | 5,045 | | 8,474 | | 14,268 | |
| Single-aisle | 9,060 | | 12,840 | | 17,273 | | 23,492 | |
| Regional jets | 2,400 | | 2,400 | | 2,400 | | 2,400 | |
| **Total** | **15,220** | | **22,339** | | **31,192** | | **44,436** | **3.6%** |
| **Fleet Forecast (Europe)** | | | | | | | | |
| 747 or larger | 261 | | 480 | | 649 | | 860 | |
| Twin-aisle | 571 | | 788 | | 1,041 | | 1,381 | |
| Single-aisle | 2,271 | | 2,778 | | 3,273 | | 3,889 | |
| Regional jets | 540 | | 486 | | 437 | | 393 | |
| **Total** | **3,643** | | **4,532** | | **5,400** | | **6,524** | **2.0%** |

(1) GDP measured in terms of 'international dollars' using 'purchasing power parity exchange rates
(2) All cost and price assumptions are at constant prices (excluding the effect of inflation).
(3) Oil price per barrel 2005 is average annual price in US$ quoted by US DOE. Forecast at constant prices

# Appendix 5
## Results Summary - Alternative Scenario.

| | | Projections | | | | | | Av growth |
|---|---|---|---|---|---|---|---|---|
| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2005-2035 |
| **GDP** | | | | | | | | |
| World (2005=100) | 100 | 111.0 | 126.6 | 142.6 | 158.7 | 176.4 | 194.7 | |
| Annual % variation | 4.3% | 2.1% | 2.7% | 2.4% | 2.2% | 2.1% | 2.0% | 2.2% |
| Europe (2005=100) | 100 | 106.1 | 114.8 | 123.3 | 131.6 | 140.4 | 149.6 | |
| annual % variation | 2.4% | 1.2% | 1.6% | 1.4% | 1.3% | 1.3% | 1.3% | 1.4% |
| **WORLD OIL PRICES (4)** | | | | | | | | |
| Price per barrel | $51.87 | $58.69 | $66.40 | $75.12 | $85.00 | $96.16 | $108.80 | |
| Index (2005 = 100) | 100 | 113.1 | 128.0 | 144.8 | 163.9 | 185.4 | 209.8 | |
| Annual % variation | 41.1% | 2.5% | 2.5% | 2.5% | 2.5% | 2.5% | 2.5% | 2.5% |
| **AIR FARES** | | | | | | | | |
| Index (2005 = 100) | 100 | 98.7 | 98.0 | 97.8 | 98.2 | 99.3 | 101.1 | |
| Annual % variation | | -0.3% | -0.2% | 0.0% | 0.1% | 0.2% | 0.4% | 0.0% |
| **Passenger traffic forecast** | | | | | | | | |
| World (2005 = 100) | 100 | 113.6 | 132.4 | 151.1 | 169.2 | 188.1 | 205.9 | |
| Annual average % growth | | 2.6% | 3.1% | 2.7% | 2.3% | 2.1% | 1.8% | 2.4% |
| Europe (2005=100) | 100 | 108.2 | 118.8 | 128.8 | 137.8 | 146.3 | 154.0 | |
| Annual average % growth | | 1.6% | 1.9% | 1.6% | 1.4% | 1.2% | 1.0% | 1.4% |
| **Cargo traffic forecast** | | | | | | | | |
| World (2005 = 100) | 100 | 116.4 | 140.6 | 166.2 | 192.6 | 222.2 | 252.8 | |
| Annual average % growth | | 3.1% | 3.9% | 3.4% | 3.0% | 2.9% | 2.6% | 3.1% |
| Europe (2005=100) | 100 | 109.4 | 122.6 | 135.6 | 148.3 | 161.4 | 174.7 | |
| Annual average % growth | | 1.8% | 2.3% | 2.0% | 1.8% | 1.7% | 1.6% | 1.9% |
| **Fleet Forecast (World)** | | | | | | | | |
| 747 or larger | 960 | | 1,329 | | 1,784 | | 2,246 | |
| Twin-aisle | 2,800 | | 3,545 | | 4,504 | | 5,752 | |
| Single-aisle | 9,060 | | 10,608 | | 12,249 | | 13,203 | |
| Regional jets | 2,400 | | 2,400 | | 2,420 | | 2,457 | |
| **Total** | **15,220** | | **17,881** | | **20,958** | | **23,658** | **1.5%** |
| **Fleet Forecast (Europe)** | | | | | | | | |
| 747 or larger | 261 | | 315 | | 385 | | 465 | |
| Twin-aisle | 571 | | 714 | | 894 | | 1,119 | |
| Single-aisle | 2,271 | | 2,235 | | 2,177 | | 1,921 | |
| Regional jets | 540 | | 491 | | 450 | | 415 | |
| **Total** | **3,643** | | **3,754** | | **3,905** | | **3,921** | **0.2%** |

(1) GDP measured in terms of 'international dollars' using 'purchasing power parity exchange rates
(2) All cost and price assumptions are at constant prices (excluding the effect of inflation).
(3) Oil price per barrel 2005 is average annual price in US$ quoted by US DOE. Forecast at constant prices


**For further information contact:**
James Cunningham, Head of Economic Development, Renfrewshire Council.

**E-mail:** james.cunningham@renfrewshire.gov.uk
**Tel:** 00 44 141 842 5877