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FOR PUBLIC POLICY

STUDY OF AIRCRAFT MAINTENANCE
DEMAND AND SUPPLY

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CONTENTS

3	Key Findings
5	Executive Summary
9	Maintenance Demand
	Commercial Airline Industry
	Military
	Freight/Cargo
	VIP Aircraft
	Demand Summary
17	Maintenance Supply
	The United States
	Employment in the Americas
	Conclusions
22	Other Considerations
	Globalization
	Fleet Reconfiguration/Aircraft Specialization
	Infrastructure Reconfiguration
27	Appendix A
	Maintenance Capacity In The Americas
29	Appendix B
	Maintenance Capacity In Asia, Africa, Middle East, Oceania
31	Appendix C
	Maintenance Capacity In Europe
32	Appendix D
	Capacity By Aircraft Type In The Americas:
34	Appendix E
	Capacity By Aircraft Type In Asia, Africa, Middle East Oceania
35	Appendix F
	Maintenance Capacity By Aircraft Type In Europe
37	Appendix G
	Maintenance Employment In the Americas:
38	Appendix H
	Maintenance employment in Asia, Africa, Middle East, Oceania
39	Appendix I
	Maintenance Employment Statistics for Europe

Key Findings

The following are the key findings of this report regarding the viability of a new aircraft maintenance facility at Pittsburgh International Airport (PIT), and the overall state of supply and demand of and for such facilities:

- The viability of the anticipated new facility at PIT seems assured with or without participation of USAirways. Extension of such a facility to that airline on a favorable lease basis is critical to the welfare of USAirways; however, demand for the facility will also be strong from growing, efficient competitors in the global airline industry, as well as from the growing number of independent providers of maintenance services.
- The facility is sustainable and justified with USAirways as its principal tenant; it is potentially more valuable to other participants in the aircraft maintenance industry as that industry evolves in the near term future.
- Research supports a need for an additional 1.4 million to 3.4 million square feet of domestic (United States) maintenance facilities over the next five to 10 years. The market for maintenance services will generate between \$3 and \$4 trillion in revenues over the next 20 years.
- The principle sources generating growth in demand for maintenance services, translating into additional facilities requirements are:
 - Outsourced maintenance from the commercial airline industry,
 - Significant aircraft maintenance growth from the US military,
 - Explosive growth expected in maintenance of cargo aircraft and conversions of former passenger aircraft to cargo freighters; and,
 - Significant growth in maintenance demand for VIP aircraft.
- Utilization demand for new facilities is expected to come from a global array of independent maintenance companies that are flexible, dynamic and efficient.
- Other demand will come from the growth of successful, efficient and profitable newer airlines unburdened by the legacy issues of old line airlines.
- Globalization is close to making aircraft maintenance a commodity, with a key requirement that international enterprises in the field establish facilities close to

their customers. Thus it is expected that foreign ownership of US maintenance facilities will increase.

- Demand for facilities and staff capable of servicing the growing Airbus fleet will grow more rapidly than demand for facilities devoted to Boeing and McDonnell Douglas aircraft.
- Personnel costs are the key inflator of airline expenses in all areas, including maintenance. The report demonstrates that one principal competitive advantage enjoyed by newer airlines is a much more efficient use of labor; the future of the airline industry will see these efficiencies captured by all surviving airlines, most likely through the elimination of internal maintenance operations, or a dramatic restructuring of those operations. The demand for outsourcing and new facilities generated by this trend is difficult to overstate.
- The two most significant sources for increased demand for maintenance services at present are expected to be growth in military efforts to extend the life cycle of current transport aircraft, and the conversion of decommissioned passenger aircraft to freighters.
- The supply side of the maintenance industry is highly concentrated, with fewer than 100 operators controlling nearly 31 million square feet of maintenance facilities worldwide. The trend toward consolidation is expected to continue, and investment in large, rather than small facilities is the norm. The industry itself is lucrative, and populated by substantial and well-capitalized organizations that are financially better off than most airlines.
- Airport Operators must recognize the need to be able to operate flexibly and independently to meet the needs of the air transportation markets they serve. As captives of local economies and the demand for air travel derived therefrom, airports will increasingly be required to seek and build revenue sources independent of the cyclical fluctuations in commercial passenger air travel.

EXECUTIVE SUMMARY

In the climate of uncertainty following recession and the attacks of September 11 that effectively placed this country on war footing, estimating the viability of a new maintenance facility is surprisingly easy.

Demand

The research results support a need for an additional 1.4 million to 3.4 million square feet of domestic maintenance facilities over the next five to 10 years in order to meet increased demand from the following growth sources:

- Outsourced maintenance from the commercial airline industry
- Significant maintenance growth from the military
- Explosive growth expected in maintenance of cargo aircraft and conversions of former passenger aircraft to cargo freighters
- Limited but none the less significant growth in maintenance demand for the so-called VIP aircraft market

The likely providers (occupants) of the new space come from a global array of independent maintenance companies that currently employ nearly one third of the more than 200,000 aircraft maintenance workers worldwide. It is the independent segment of the aircraft maintenance industry that is flexible, dynamic and efficient to the extent required by the demands of the changing air transportation realities after September 11. Most importantly, this segment of the industry represents a plethora of viable tenants for new maintenance facilities, irrespective of the demand for such facilities from airlines themselves. While this is not to understate the likelihood that airlines such as Alaska Airlines, which has clearly stated its intention to expand its maintenance operations to meet expected growth (a similar situation to the nation's successful discount and regional airlines, i.e. Jet Blue, AirTran, ATA, etc.) will take a share of new facilities, it provides a level of comfort that any new facility will not lack for tenants eager to put such a facility to productive and profitable use.

This is also not to discount the probability that a major airline, in the process of restructuring itself to capture efficiencies, would not find such a new maintenance facility attractive as part of an effort to streamline operations. One possibility worthy of further

research is the ability to and interest in spinning off of captive maintenance operations by entering into an agreement for contracted services with former maintenance employees.

For, it is clear that the principal advantage the profitable airlines have over their unprofitable competitors is a much more efficient employment of labor in all functions, and especially maintenance. As is pointed out in the body of the report, it is the disparity in labor costs, rather than the financing, fuel and other “overhead” expenses that spells the difference between losses and profitability among the airlines.

Supply

Supply of maintenance facilities is highly concentrated as to ownership, as is to be expected in an industry that demands economies of scale and specialization. The United States currently accounts for about 42 percent of worldwide capacity, with the largest facilities and employers being the “captive” maintenance arms of domestic airlines.

While the US share of worldwide capacity is expected to decline, as operators, particularly in Asia, expand more rapidly to capture the exponential growth in air travel services demand there, that does not mean that US capacity will not expand. And, expansion may be more rapid than forecast due to increased interest in US markets by foreign entrepreneurs who read the need for facilities that are capable of handling the significant strategic changes that are certain to occur in the domestic US commercial airline industry. More significantly, the increased demand in military aircraft maintenance may be more than enough to offset any slower growth in commercial services demand, and cargo/freight demand is also expected to grow at above normal rates over the next 10 years.

As consolidation of the airline industry occurs, concentration of aircraft maintenance suppliers will also continue. It is likely that the share of market owned by independents will increase, and that their expansion will be into new facilities, rather than facilities available through decommissioning by domestic airlines.

Other Considerations

The use of the term “globalization” has become outworn; however, in the case of the aircraft services and maintenance industry, globalization is not just a buzzword, it is a fact of life. Increasingly, competition for aircraft maintenance services is conducted on a global basis. It will soon make as much sense for a Chinese airline to

have its aircraft serviced in Europe as in Asia, and for an American aircraft operator to have its fleet serviced overseas rather than domestically. Thus, the tenants of US based maintenance facilities are increasingly foreign owned companies. The upshot of globalization, therefore, is larger maintenance facilities, increasingly operated by independent, perhaps foreign owned, operators keen on penetrating international markets in order to meet the customers where they are headquartered.

For the US market this means that, as demand for maintenance, both outsourced and independent increases, the likelihood that the number of competitors vying for new facilities will include a growing presence of foreign companies, such as Jet Aviation, and Evergreen, just to name two.

As, worldwide, commercial airline companies reconfigure their fleets for increased efficiencies and to fit new strategic imperatives, it is interesting to note that domestic US capacity to service the Airbus family of aircraft is as follows:

Some 8.3 million square feet of reported capacity is indicated as being capable of meeting the servicing requirements of Airbus craft. This represents only about 50 percent of current capacity. In another scenario, this indicates that the personnel at half of the current maintenance operations in the US do not have experience servicing Airbus craft. That situation is expected to have to change, as the airbus family absorbs an increasing share of the US fleet. The increasing use of regional jets indicates another opportunity for independent maintenance companies to achieve “specialized competitive advantage” in maintenance service, as is referenced in a Boeing analysis of globalization cited in the body of this report. This is expected to provide further impetus for outsourcing, and lead to an increasing independent “share” of the US maintenance market.

Airport operators are increasingly forced to operate independently and flexibly to meet the dynamic needs of the air transportation markets they serve. In all areas from security, to customer amenities and services such as de-icing and baggage handling, airports must increasingly become independent operators in their own right. This will inevitably involve utilizing excess airport revenues in accordance with FAA mandates, to make investments that increase the value of the airport as an economic entity. As this report demonstrates for a variety of reasons, increasing an airport’s maintenance capabilities is a sure bet to develop that facility’s potential to its fullest.

Summary

The viability of the anticipated new maintenance facility at Pittsburgh International Airport would seem to be assured with or without participation of USAirways. On the one hand, a new facility extended to that airline on a favorable lease basis would be critical to the welfare of that enterprise no matter what configuration the new USAirways takes as part of its new business plan. Strategic flexibility as to maintenance of a changing fleet configuration in a dynamic market is essential, as is the ability to wring increasing efficiencies out of both maintenance labor and maintenance facilities. The new building would be key in both regards, and as such would be protected should the airline reorganize.

More importantly, however, is that the facility would be in high demand regardless of the future course of USAirways, both from growing, efficient competitors in the global airline industry, as well as from independent providers of maintenance services on a worldwide basis. The market for maintenance services is expected to generate \$3 to \$4 trillion in revenues over the next 20 years, and, as we have estimated, normal growth in the market segments we have identified would seem to support the need for a minimum of one million square feet in additional maintenance facilities space over the next five years.

It is our conclusion that the facility would be sustainable and justified with USAirways as its principal tenant; and, it would potentially be more valuable to other participants in the aircraft maintenance industry as that industry evolves over the near term future.

Maintenance Demand

Commercial Airline Industry

By far the greatest demand for aircraft and equipment maintenance in any nation currently comes from its domestic airline industry. As can be seen in Appendices G through I, the largest maintenance employers of both human and capacity resources are the so-called “captive” Maintenance Service Organizations (MSO) of the major airlines. On pages 18 and 19 of this report is a discussion of the largest maintenance employers in the Americas as reported by Air Transport World in its “Maintenance 2001” year-end study. United Airlines, Delta Airlines, and American Airlines ranked first, third and fourth, with Air Canada fifth.

Driven by recession, economic and industry trends that have depressed airfares and revenues, declining demand for air travel in general, and pressures resulting from the calamitous events of September 11, the airline industry is restructuring. Entire fleets are being reconfigured in efforts to achieve aircraft synergy with route systems and emerging new market trends. The major airlines especially are now engaged in top to bottom strategic restructurings. As we have reported elsewhere:

A recovery in business travel is seen as the key to profitability for most major airlines, which failed to adjust when air travel peaked and then began a precipitous slump in late 2000. Well before the events of September 11 it was clear that business travel demand had been severely eroded, and the dramatic decline in leisure travel after the terrorist attacks was simply the last straw. Demand has retreated across the board, and there is little prospect for any near term return to previous traffic levels and growth rate. In fact, consensus holds that only the elimination of one or two major airlines will bring air travel supply in line with demand.

While Southwest Airlines and other “discounters” have weathered the disastrous climate since September 11 and are in little danger of failure, the “main line” airlines face Herculean cost cutting efforts just to survive. The latter suffered a

staggering \$3.4 billion in operating losses in the first quarter. The second quarter outlook is perhaps more dismal due to the fact that the industry is running out of cash. The biggest airlines have engaged in creative financing, selling aircraft and other assets and reacquiring their use under non-cancelable “operating leases.” United has \$24 billion of these obligations, which don’t appear on the company’s balance sheet. USAirways has \$10 billion of these non-cancelable leases while Southwest has but \$2.8 billion and Alaska Airlines only \$2.1 billion. Every major airline hocked assets in order to generate cash in previous downturns, and airlines such as USAirways and others, which now must replace a good portion of their aircraft fleet, may find it financially impossible to do so without first demonstrating they have achieved significant internal cost reductions.¹

A critical effort is underway at all airlines to achieve efficiencies, cut costs and accomplish system wide changes that position them to be competitive in the new, post September 11 reality. A key cost component for all industry participants is airplane maintenance, repair and overhaul, estimated to account for \$1.5 trillion in worldwide expenditures between 2001 and 2020.² When the estimated costs of airplane servicing and major modifications are added, the total costs of aircraft maintenance are expected to exceed \$2.1 trillion over that same period.

Each major airline spends hundreds of millions of dollars annually on straight maintenance of its fleet of aircraft. The primary requirement is that aircraft safety be maintained; the secondary priority is that aircraft remain in service—that maintenance be conducted as expeditiously as possible and the aircraft returned to its revenue-generating role as quickly as possible. When airplanes in the shop do not return to service, there is a considerable operations replanning cost. There is also an airplane financing cost. On the other hand, every day eliminated from a heavy check schedule is a potential day of revenue-generating service. According to one major industry player, this broader view of maintenance costs reflects an increasing tendency for airlines to regard maintenance,

¹ Allegheny Institute Policy Brief, Volume 2, No. 22, May 7, 2002

² Current Market Outlook 2001, The Boeing Company

repair, and overhaul (MR&O) in terms of its effects on airplane utilization and the resale value of airframes, engines and components.³

Each airline has reacted differently to the dynamic situation facing it in today's market. One domestic airline, Alaska Airlines, typifies the thinking, we believe of what we view as the "second tier" airlines.

A recent inquiry discovered that Alaska currently employs some 1,300 unionized workers in their maintenance operations. They indicated as recently as May 3, 2002, that they expect to increase both maintenance activity and employment over the next five to 10 years. And, according to Heidi Olsen, in the airline's finance division, Alaska also will be looking seriously at outsourcing maintenance over that same period.

Alaska Airlines in April of 2002, boarded somewhat less than one-third the passengers USAirways served, 1,150,000 passengers reported at Alaska vs. 4,336,187 reported at USAirways. What is important to note is that USAirways is estimated to employ roughly five times as many individuals in its maintenance operations as does Alaska. At the end of the first quarter of 2002, Alaska reported its aircraft fleet totaled 96 jets, while USAirways reported 310 total. USAirways will spend roughly \$160 million more annually on maintenance than will Alaska Airlines. But it is in the area of personnel costs that the old-line airlines suffer disproportionately. USAirways, operating a fleet of some 310 jets, reported personnel costs that were 91 percent greater than Southwest Airlines' and 360 percent greater than Alaska Airlines' costs. The obvious operating efficiencies enjoyed by the "second tier" airlines must be achieved by the old-line operators if they are to survive the decade.

There is little question that maintenance efficiencies distinguishing the low cost airlines from the old-line airlines are in the number and cost of personnel devoted to that function. This is easily verified by the fact that the differences in the line item "maintenance" at each airline is almost entirely predicted by the number of aircraft in the respective airline's fleet. For example, Southwest Airlines maintained 359 aircraft at a cost of \$97 million during the first quarter of 2002. American Airlines maintained a fleet of 556 units at a cost of \$266 million during the same period. The difference between "pure maintenance" costs at Southwest vs. those at American is quite entirely predicted

³ Boeing, Op.Cit.

by the difference in respective fleet sizes. And, the difference between personnel costs at, say, Alaska Airlines, vs. those at United Airlines, on the other hand, is similarly explained. Alaska Airlines utilizes 1,300 maintenance workers, while United employs some 10,000. As would be expected, United Airline's personnel costs were 8.27 times those of Alaska Airlines' during the same quarter. And, while Alaska employs 13 maintenance workers per airplane, American requires nearly 20.

Clearly, then, like Alaska Airlines, the old-line airlines will increasingly be forced to look to outsourcing maintenance services if they hope to remain competitive with their low cost competitors. Independent maintenance companies have recognized this trend, and many are now forecasting growth in "heavy maintenance" outsourced to them by the major airlines as their most significant opportunity over the next five to 10 years.

Consider the following comments from AAR Aircraft Services of Oklahoma City, OK:

"The Company continues to take aggressive steps to reduce costs and maintain its solid financial position. We have reduced annual operating expenses by nearly \$25 million and generated more than \$10 million of cash from operations since September 1. In addition, we have lowered annual interest expense by more than \$3.5 million," said AAR President and CEO David P. Storch. "In the month of February, the Company strengthened its capital structure with a common stock offering which raised \$34.5 million. We believe the cash raised will provide us the financial flexibility we need to execute our business strategy."

"As the airline industry begins to recover from its current levels, we expect to see increased outsourcing opportunities for our products and services which have demonstrated value-added benefits to our airline customers," Storch continued. "Additionally, we are expecting to capitalize on trading opportunities generated by the market imbalances. We are expanding our presence as the logistics provider of choice for the U.S. Armed Forces and its major contractors and we expect to see growth in our business supporting the U.S. Military's mobilization needs."

Other Maintenance Demand

Military

As is mentioned by the CEO of AAR Aircraft services and other maintenance providers, military work is expected to be a significant source of demand. Note the following excerpt from a recent article by the Military Analysis Network concerning the Air Force's newest cargo aircraft (*italics added*):

Based on a buy of 120 aircraft, the last C-17 delivery will be in November 2004. The original specification from McDonnell Douglas defined a service life of 30,000 hours. *Modification programs will keep the aircraft in line with current and future requirements for threat avoidance, navigation, communications, and enhanced capabilities. These modifications should include global air traffic management (GATM) and automatic dependent surveillance to meet anticipated navigation requirements. Commercially available avionics and mission computer upgrades are being investigated to reduce life-cycle costs and improve performance. Also, upgraded communication systems to enhance worldwide voice and data (including secure) transmission will support command and control.*⁴

The latest estimates for maintenance, conversion and other upgrade related services for the military's cargo fleet have been quite ambitious, in part due to the near war footing the nation has been on since September 11, 2001. In a paradoxical situation, the recession induced budget deficits have combined with increased demands on the military's tactical air support fleet to lead military planners to look toward maintenance solutions to extend serviceable lives of nearly all current support aircraft.

This means that over the next five years, at least, military spending on support aircraft maintenance will generate increasing demand for independent maintenance providers.

⁴ Military Analysis Network, April 25, 2000

Freight/Cargo

Visits to the web sites of the independent maintenance companies reveals that, while they have suffered some reversal due to the changed economic conditions since September 11, none have seen the dramatic downturn that has affected the domestic airline industry. What's more, most of the independent maintenance firms are diversified, performing work for the US government (military and aerospace) as well as work for cargo and freight firms such as UPS and Fedex, each of which spend one billion dollars annually on maintenance, and foreign airlines. Such independent companies are also able to diversify into all "opportunity" areas, rather than march to the strategic orders of a commercial airline. As an example, while forecasts indicate that the US share of global passenger traffic is expected to decline over the next 20 years, the same forecasts indicate that the global cargo fleet is expected to double in order to keep up with growing demand.⁵ And while the outlook for passenger demand is severely cloudy post September 11, cargo traffic is not similarly impacted.

Indeed, experts say that keeping up with growth in demand will require innovation, flexibility and increased efficiency by the world's freight operators. One obvious area to benefit from this increased demand is the passenger to cargo conversion market, with a concomitant expansion in that segment of the maintenance industry.

It is also expected that commercial airlines will seek to maintain or expand their share of the cargo market. This however presents both a problem and a unique opportunity. With the airline industry's move to smaller aircraft (regional jets) the actual cargo capacity of the airlines' fleets will be reduced. However, airlines may be in the position to convert the planes being decommissioned as passenger liners to freighters, sparking additional demand for such maintenance activity while engaging in fierce competition for this market. In any case, the bulk of the new freighter craft supply delivered to meet demand over the next 10 years will be in the form of passenger to freighter conversions.⁶

⁵ Airbus Global Market Forecast 2000-2019

⁶ Airbus Global Market Forecast

It is this need for increased flexibility and adaptability in the face of new and emerging opportunities that ultimately gives rise to the consensus that the maintenance market over the next 20 years will come increasingly under the dominance of independent firms on a worldwide scale. What's more, foreign investment in American maintenance capacity is expected to grow over the next 10 years, as well.

VIP Aircraft

A third "non commercial" source of maintenance demand over the next decade will come from what is sometimes called the "corporate jet" market. Post September 11, the demand for and utilization of independently chartered aircraft by business and industry has grown significantly. This segment of the market is also expected to evolve and grow over the next 10 to 20 years, with aircraft size and life cycles increasing the need for independent maintenance facilities at major airports around the country.

While the significance of this demand is difficult to pinpoint, there is little doubt that it will account for hundreds of millions of dollars in revenues for the maintenance industry in short order.

Demand Summary

In fiscal 2000, Commercial Aviation Support Services (CASS) represented a \$95 billion annual market. The best estimates going forward since September 11, 2001, indicate that demand for support services has actually increased, and that spending on maintenance, retrofit and other services will grow beyond the \$2.1 trillion suggested by The Boeing Company, to a level of \$3 trillion over the next 20 years.

Primary beneficiaries of this growth are expected to be the independent providers of such services, due to several primary factors:

- Increasing outsourcing of maintenance and related services by commercial airline operators
- Increased demand for military maintenance and retrofit services in an effort to extend service lives of support aircraft

- Expected growth of cargo and freight activity on a global basis that will provide an outlet for decommissioned passenger aircraft as an alternative to new aircraft. This is especially important in the developing economies, including China.

Maintenance Supply

We have broken down our analysis of maintenance facilities supply to three global arenas: The Americas, Asia-Africa-Middle East-Oceania, and Europe.

The Americas have, by a considerable margin, the largest reported concentration of maintenance facilities supply, at 17.3 million square feet, vs. 10.6 million square feet in Europe and only 3.6 million square feet in Asia, et al.⁷ It should be noted that the figures for the Americas do not include several of the major airlines captive maintenance operations, and may be understated by as much as 5 million square feet. However, the characteristics we wish to consider can be seen as fairly represented in the sample under analysis. The configuration of the facilities, in terms of size and utilization is as follows:

AMERICAS	Size of Facility	#	Total Sq. Ft.
Reported Sizes of:	< 50,000 sf	5	93,587 sf
Maintenance Facilities	≥ 50,000 sf < 100,000 sf	9	628,595 sf
In the Americas	≥ 100,000 sf < 500,000 sf	9	2,231,000 sf
	≥ 500,000 sf < 1,000,000 sf	6	3,698,000 sf
	> 1,000,000 sf	5	10,018,336 sf
TOTALS		34	16,669,518 sf

For our purposes, only those facilities larger than 50,000 square feet are considered as relevant supply. Ownership of the maintenance supply in the Americas can be seen as highly concentrated, and operations can be characterized as highly centralized. The same can be said to be true for Europe and Asia, et al.

EUROPE	Size of Facility	#	Total Sq. Ft.
Reported Sizes of:	< 50,000 sf	15	315,428 sf
Maintenance Facilities	≥ 50,000 sf < 100,000 sf	11	719,236 sf
In Europe	≥ 100,000 sf < 500,000 sf	10	2,415,336 sf
	≥ 500,000 sf < 1,000,000 sf	0	0 sf
	≥ 1,000,000 sf	5	7,187,748 sf
TOTALS		42	10,637,748 sf

ASIA, ET AL	Size of Facility	#	Total Sq. Ft.
Reported Sizes of	< 50,000 sf	7	233,921 sf
Maintenance Facilities	≥ 50,000 sf < 100,000 sf	5	300,692 sf
In Asia, et al.	≥ 100,000 sf < 500,000 sf	6	807,051 sf
	≥ 500,000 sf < 1,000,000 sf	3	2,294,000 sf
	≥ 1,000,000 sf	0	
TOTALS		21	3,635,479 sf

⁷ Air Transport World Maintenance Directory 2001

The United States

Some 29 operators of maintenance facilities concentrations of 50,000 square feet or more are found in the United States. In fact, the United States accounted for 78 percent of the reported maintenance facilities in the table above for The Americas, and accounts for about 42% of overall world wide capacity. It is a telling point that fewer than 100 operators control nearly 31 million square feet of maintenance facilities worldwide. This concentration leads to great efficiencies, and it is also indicative of a well-capitalized and financially stable industry. Indications of intentions to expand, particularly as relates to globalization of operations by particular large operators, can thus be taken seriously as these firms have the capacity to make such significant investments.

A primary consideration regarding the justification for adding new capacity to the maintenance system in the US is the expected audience for its utilization.

As was indicated in the previous analytical section, “utilization” demand for new facilities comes not only from domestic airlines, but also from Original Equipment Manufacturers (OEMs) and the military, and air cargo and freight forwarders around the world. While the passenger sector is experiencing difficulty rebounding from the decline experienced since the third quarter, roughly, of 2000, the other sectors are enjoying not just rebounded growth, but are forecast to expand significantly over the next decade.

Currently the employment statistics for the aviation maintenance industry are as follows:

North and South America⁸

Employment	88,000
Number of Firms	42
Largest	
United Services	15,800
GE Engine Services	11,300
Delta TechOps	11,000
American Airlines	9,000
Air Canada Technical Services	8,000
Pratt & Whitney	5,500
Timco	4,000
Varig Engineering & Maintenance	3,570
Boeing Airplane Services	2,800
Goodrich Aviation Services	2,600
LanChile S.A.	1,500
Dallas Airmotive	1,450
Seman Peru	1,350

An interesting and telling efficiency contrast can be provided by comparing the number of employees and square footage of maintenance facilities of Delta TechOps, Delta Airlines' captive maintenance operation, to those employed by several independent maintenance services providers with operations throughout the United States.

<u>Service Provider</u>	<u>No. of Employees</u>	<u>Total Sq. Ft.</u>	<u>SF per Employee</u>
Delta TechOps	11,000	2,700,000	245
Aviation Management	820	800,000	975
Dee Howard	750	850,000	1,133
Jet Aviation	650 (US)	608,966	936

Free from the constraints associated with the legacy of major airlines, and located away from the congestion of major industry infrastructure centers occupied by the captive maintenance systems of the airlines, service providers like Aviation Management, Dee Howard and Jet Aviation are able to gain efficiencies, cost advantages, and a competitive edge. What's more, these companies are able to diversify their customer base, operate on a profit center, rather than a cost center basis, and capture the opportunities to provide cutting edge service and maintenance products and services as those opportunities evolve in the changing marketplace. Dee Howard is, in fact, a subsidiary of an Italian Aerospace company, and markets its products and services around the globe, as does Jet Aviation,

⁸ Air Transport Maintenance Directory, 2001. Employment figures for Asia, et al are found in Appendix H and for Europe in Appendix I. Those appendices also contain data on expected growth areas, and the number of Airbus Maintenance capable facilities in those regions.

with its corporate headquarters in Switzerland. Aviation Management is the world's largest independent airframe maintenance and overhaul station.

A review of the so-called independent (non-captives of major airlines) maintenance companies reveals that eight of them are subsidiaries of foreign companies. This confirms the fact that foreign interest in the American market is longstanding, and on the rise in recent years. In fact, one firm, Stambaugh's Air Service, a Pennsylvania firm, goes out of its way to note that it is "the oldest independent, non-foreign-owned American maintenance company."

Conclusions

The trend in the United States Domestic Market in terms of supply is toward greater concentration of maintenance operations and growth of independent suppliers. The principal impetus in this direction is provided by the need of the commercial aviation industry, in particular the "old line" airlines, to achieve ever-greater efficiency and cost effectiveness. As increased demand for outsourcing from commercial airlines evolves over the next several years, it can be expected that independent operators will have two basic options:

- Assume operation of "spun off" facilities abandoned by commercial airlines; or,
- Expand into new facilities

The latter option is the most sensible and likely for several reasons. First, the legacy effects of the major airlines maintenance facilities and operations would be exceedingly difficult to escape. Most facilities are older, are suited to fleet structures and operating strategies that are no longer viable, and would likely be the objects of a focused effort by labor unions. The trend to outsourcing is multi dimensional. As was pointed out earlier in the report, the most dramatic cost component at the major airlines is labor, and it is the high cost of maintenance labor that the airlines must seek to escape. Thus, outsourcing will require that the independent service providers utilize state of the art facilities, configured and designed to service the new fleet configurations the airline

industry will evolve into over the next five years, and with highly skilled labor that is willing and capable to work under the most flexible and dynamic conditions.

Given growth expectancies, it is estimated that an additional 1.4 million to 3.4 million square feet of maintenance facilities will be added to capacity in the United States alone over the next five to 10 years.⁹ This growth is driven by demand from the sources already outlined previously:

- Continued outsourcing by commercial airlines at all levels, “old line,” discounters, and regional airlines
- Significantly greater demand by the military for retrofit and life cycle extension maintenance on support (transport, logistics, intelligence) aircraft
- Increasing demand by air cargo and freight industry participants for independent maintenance
- Growth, difficult to estimate but none the less significant, in demand from so-called VIP aircraft users

⁹ This range of expansion is derived from current capacity, factored by expected growth in passenger traffic carried by newer, so-called “discount” and regional airlines, which we estimate will expand their maintenance capacity by at least 50 percent to service growth. Additionally, global air cargo and freight demand will generate additional capacity requirements for ongoing servicing of existing and expanded fleets, and particularly conversions of decommissioned passenger craft for service as small and mid-sized freighter craft. These “long term “ factors are exacerbated by the current military buildup generated by the “war on terrorism.” By components, then, airline industry needs: 5-10% additional capacity; cargo/freight 5-10% additional capacity; military, up to 5% additional permanent capacity. We expect that the majority of the new capacity will come on line in years 3-7 of the 10-year time line mentioned above.

Other Considerations

There are several other factors that impact the expected viability of new maintenance facilities. They will be considered in order of importance. The first is Globalization.

Globalization

The use of the term “globalization” has become outworn; however, in the case of the aircraft services and maintenance industry, globalization is not just a buzzword, it is a fact of life. As is indicated above, about half of the world’s aircraft maintenance capacity exists outside of the United States. Increasingly, competition for aircraft maintenance services is conducted on a global basis. It will soon make as much sense for a Chinese airline to have its aircraft serviced in Europe as in Asia, and for an American aircraft operator to have its fleet serviced overseas rather than domestically. Thus, the tenants of US based maintenance facilities are increasingly foreign owned companies.

Here is what Evergreen, a Taiwanese maintenance company, has to say on the matter (*italics added*):

EGAT will continue to expand its aircraft maintenance service inspired by the corporate spirit of the Evergreen Group - "challenge, innovation, team work" and the guiding principle of " Safety First, Quality is Everything."

In addition to present capabilities for wide range of aircraft types, Evergreen Aviation Technologies Corporation (EGAT) is currently developing capability to perform passenger to cargo aircraft conversions, engine module overhauls, and continuously improving aircraft maintenance services for mechanical, electrical, communication and navigation systems.

EGAT looks forward to becoming a fresh new professional force in the global airline market through delivery of superior technical skill and unparalleled services. The quality maintenance services provided by EGAT will contribute significantly to establishing Taiwan as the aviation technology maintenance center for the Asia-Pacific region.

Virtually all of the major players in the airframe and aircraft maintenance industries around the world see the US market as an important source of future growth. Expectations are that, when the recovery in air travel services occurs, it will occur first in the United States. Another factor turning eyes toward the US is the prospect, now

deemed a certainty in the next decade, of more foreign entry to the US air travel services market.¹⁰

As Boeing Corporation has stated (*italics added*):

A major driver of consolidation and joint venture activity has been *the imperative to achieve global reach. Globalization of the airline industry has created pressure on after-market suppliers to service their customers worldwide. This may mean being able to supply parts and components wherever a customer's airplanes fly. It may also mean having maintenance facilities available close to major customers. Key customers are more likely to outsource MR&O work if they*

¹⁰ Note the following excerpt from the Industrial Technology Research Institute published in October, 1999:

Promoting Taiwan to become an Asia-Pacific regional aircraft manufacturing and maintenance center is a crucial part of the Government's policy of building the island as an Asia-Pacific regional operation center. The newly established International Consortium for Aircraft Service (ICAS) may accelerate the tempo since aircraft cargo conversion is the highest level in the aircraft maintenance industry. China Airlines Ltd. (CAL), Air Asia Company Limited, Evergreen Aviation Technologies Corp. (EATC), and Aerospace Industrial Development Corporation (AIDC) signed a Letter of Intent on October 5, 1999. This cooperation was made possible from the support of Dr. Chii-Ming Yiin, Administrative Vice Minister of the Ministry of Economic Affairs (MOEA), along with the help from the Center for Aviation & Space Technology (CAST) of ITRI and the Committee for Aviation and Space Industry Development (CASID) of MOEA.

The purpose of establishing an aircraft cargo conversion company is to target the booming air cargo transportation market that is driving a huge demand for air cargo carriers in the next two decades. Currently, the annual growth rate of the global air cargo transportation volume is predicted at 6.5%. In the next 20 years, the number of global air cargo carriers will increase from the current 1,500 to 3,000. If taking the replacement of old air cargo aircraft into account, the demand for new ones is about 2,800. Over 70% of them will be converted from the current passenger carriers.

To turn a passenger carrier into an air cargo craft is a high-level and high value-added business in the aircraft maintenance industry. Using Boeing 747-200 as an example, the expense for conversion exceeds US\$20 million if carried out by the original manufacturer. Major works involved are strengthening the upper deck and supporting structure, the manufacturing and installation of larger doors for air cargo loading/unloading, rebuilding aircraft systems, so on and so forth. The workload is about four to six times more than an aircraft that needs heavy maintenance. Since there are considerable changes in the aircraft structure, it needs to complete relevant engineering design and obtain the Supplemental Type Certificate (STC) before starting the conversion. The whole process and technologies involved are similar to developing a new aircraft.

Currently, CAL, Air Asia, and EATC are all US FAA certified companies for aircraft maintenance. The repairing and maintenance technologies as well as the facilities they established have met the international standards. Their reputation as professional aircraft maintenance firms will be further upgraded once this newly formed company receives orders from abroad. Furthermore, AIDC, as a leading aerospace company in Taiwan, is an important partner for STC. With AIDC's capability, it can speed up the development of the conversion STC, and thus will make ICAS very competitive internationally.

Among all the air cargo carriers with market potential, those that still need STCs include Model 767, 757, 747-400 and 737 of Boeing and Model A320, A330 of AirBus. If Taiwan is able to become an Asia-Pacific regional aircraft cargo conversion center, the annual production value is predicted at NT\$10 billion. Furthermore, it can strengthen domestic R&D capability in aircraft conversion, and it will certainly help to promote Taiwan as an Asia Pacific aircraft manufacturing and maintenance center.

are relieved of responsibilities for logistics, whether this entails positioning parts or ferrying airplanes.

Efforts to increase the reach of MR&O networks also result in increasing their scale. Opportunities for specialization occur if some facilities and/or partners can be designated centers of excellence. This allows each of them (maintenance companies) to focus on a smaller number of airplane or engine models. This effect is to create an environment conducive not only to scale economies but also to learning curve benefits and process improvements.

The upshot of globalization, therefore, is larger maintenance facilities, increasingly operated by independent, perhaps foreign owned, operators keen on penetrating international markets in order to meet the customers where they are headquartered.

For the US market this means that, as demand for maintenance, both outsourced and independent increases, the likelihood that the number of competitors vying for new facilities will include a growing presence of foreign companies, such as Jet Aviation, and Evergreen, just to name two.

Scale requirements are the number one driver of airplane maintenance market organization. High capital costs, the need for sufficient workflow to maximize use of equipment, skilled labor requirements, and productivity/volume relationships are all characteristics of the industry. Infrastructure investment accompanying fleet changes to new aircraft, airplane size, the timing of the fleet buildup, and anticipated reliability of new models may make such infrastructure (maintenance hangars, etc.) difficult to justify for any one operator.¹¹

Just as airlines have been forced to react to the new air travel realities post September 11, major international suppliers of maintenance services have recognized a need to focus on the new emerging growth realities in the industry. Joint ventures, outsourcing, consolidations are occurring and point to conditions that generate demand for state of the art facilities operated increasingly by OEMs and specialists, rather than the major airlines themselves.

¹¹ Boeing. Op. Cit.

Fleet Reconfiguration/ Aircraft Specialization

As, worldwide, commercial airline companies reconfigure their fleets for increased efficiencies and to fit new strategic imperatives, it is interesting to note that domestic US capacity to service the Airbus family of aircraft is as follows:

Some 8.3 million square feet of reported capacity is indicated as being capable of or dedicated to meeting the servicing requirements of Airbus craft. This represents only about 50 percent of current capacity. Put another way, this indicates that the personnel at half of the current maintenance operations in the US do not have experience servicing Airbus craft. That situation is expected to have to change, as the airbus family absorbs an increasing share of the US fleet.

About 85 percent of current US capacity is rated as capable of servicing the Boeing and McDonnell Douglas aircraft families.

In Asia, et al, and Europe as would be expected, the numbers are somewhat different. Asian capacity is 69 percent Airbus capable, and 99 percent Boeing or McDonnell Douglas Capable. Europe, on the other hand, is 85 percent Airbus, and 92 percent Boeing or McDonnell Douglas capable.¹²

The figures for these aircraft maintenance ratings indicate strongly that there is great overlap and flexibility among independent suppliers of aircraft maintenance—they clearly are capable of adjusting to market trends and achieving a high level of maintenance service capability for any emerging aircraft or strategy.

Thus, in the domestic US market, the increasing use of regional jets indicates another opportunity for independent maintenance companies to achieve “specialized competitive advantage” in maintenance service, as was referenced in the Boeing segment on globalization cited previously. This is expected to provide further impetus for outsourcing, and lead to an increasing independent “share” of the US maintenance market.

¹² See Appendices D,E,F

Infrastructure Reconfiguration

One factor that came clear after September 11, 2001, is that airport operators are increasingly forced to operate independently and flexibly to meet the dynamic needs of the air transportation markets they serve. In all areas from security, to customer amenities and services such as de-icing and baggage handling, airports must increasingly become independent operators in their own right.

A trend that has not been missed by airports around the nation is the decreasing loyalty and increasing demands displayed by their major tenants, the old-line airlines. As they should be, these organizations are strictly motivated by the bottom line, and must continually revalue the locations and markets they serve. Discount and regional airlines are propelled to those markets they perceive as most profitable and away from those in which they cannot quickly achieve both penetration and success at the bottom line.

Whatever the domestic airline industry looks like going forward, one thing is certain. Airports are captives of the performance of local economies, and the demand derived therefrom for air travel and related services. Just as airlines are looking to build revenues unrelated to strictly passenger travel, so will airports be increasingly required to seek and build revenue sources that are independent of cyclical fluctuations in commercial passenger air travel.

It is clear that airports represent valuable real estate for reasons unrelated strictly to moving people from city A to city B. The support industry upon which passengers and aircraft alike depend for successful and safe travel is expected to be a shining light in the industry going forward. Airport operations across the country will be expected to capture their share of this growth in the future. It should be noted that the majority of independent operators of this nation's most successful and growing maintenance facilities choose to locate their operations outside of the major "hub" and metropolitan airports, in order to achieve cost efficiencies and avoid the kind of congestion that impairs service quality.

APPENDIX A

Aircraft Maintenance Capacity In The Americas

Firm	Country	Hangar Capacity	
AAR	US	99,000 sf	
Aeroman	El Salvador	118,000 sf	
AeroMexico	Mexico	2,137,336 sf	
AeroThrust	US	NA	
Air Atlantic	Canada	24,000 sf	
Air Canada	Canada	396,000 sf	
American Airlines	US	2,781,000 sf	
Avborne	US	226,000 sf	
Aviation Management	US	800,000 sf	
AVMAX	Canada	50,000 sf	
Avtel	US	75,000 sf	
Boeing	US	500,000 sf	
Cascade	Canada	250,000 sf	
Commodore	US	50,000 sf	
Coopesa	Costa Rica	26,367 sf	
Dalfort Aerospace	US	140,000 sf	
Dallas Airmotive	US	17,400 sf	
Dee Howard	US	850,000 sf	
Delta TechOps	US	2,700,000 sf	
EADS Aeroframe	US	400,000 sf	
Evergreen	US	60,000 sf	
First Air	Canada	100,000 sf	
GE Engine Service	US/Canada	NA	
Goodrich Aviation	US	1,000,000 sf	
Hamilton Aviation	US	94,000 sf	
Jet Aviation	US	608,966 sf	
LanChile	Chile	17,820 sf	
Messier	US/Canada	NA	
Middle River	US	1,400,000 sf	
MTU Maintenance	Canada	NA	
Patriot Aviation	US	8,000 sf	
Pemco	US	521,000 sf	
Piedmont Hawthorne	US	151,000 sf	
Pratt & Whitney	US	NA	
Seman Peru	Peru	71,775 sf	
Spar Aerospace	Canada	500,000 sf	
Stambaugh's Air Service	US	78,000 sf	
ST Mobile Aerospace	US	527,000 sf	
Texas Aero	US	450,000 sf	
Timco	US	NA	
United	US	NA	
Varig	Brazil	50,820 sf	
Wood Group	US	NA	
TOTAL REPORTED SF		17,278,484*	100%

TOTAL SQUARE FOOTAGE BY COUNTRY GROUP IN THE AMERICAS

US	13,536,355	78%
Latin America	2,422,118	14%
Canada	1,320,000	8%

Reported Facility Sizes:	< 50,000 sf	5	93,587 sf
	≥ 50,000 sf < 100,000 sf	9	628,595 sf
	≥ 100,000 sf < 500,000 sf	9	2,231,000 sf
	≥ 500,000 sf < 1,000,000 sf	6	3,698,000 sf
	≥ 1,000,000 sf	5	10,018,336 sf

* Does not include the majority of “captive” maintenance facility space owned and operated by major domestic US airlines

APPENDIX B

Aircraft Maintenance Capacity In Asia, Africa, Middle East, Oceania

Firm	Country	Hangar Capacity	
Air Asia	Taiwan	NA	
Air-India	India	111,210 sf	
Alsalam Aircraft	Saudi Arabia	52,470 sf	
Ameco-Beijing	China	115,500 sf	
Ansett Australia & Air NZ	New Zealand	677,000 sf	
Bedek Aviation	Israel	NA	
CEA	China	NA	
China Aircraft	Hong Kong	NA	
China Airlines	Taiwan	141,900 sf	
China Eastern Airlines	China	39,600 sf	
China Northern Airlines	China	21,635 sf	
China Northwest Airlines	China	11,550 sf	
China Southwest Airlines	China	NA	
Evergreen Aviation	Taiwan	45,266 sf	
GE Engine Services	Various	NA	
Guangzhou Aircraft	China	41,950 sf	
Gulf Aircraft	UAE	53,882 sf	
Hong Kong Aircraft	Hong Kong	67,624 sf	
Japan Airlines	Japan	693,000 sf	
Jet Aviation	Singapore	50,816 sf	
Korean Air	Korea	Complete 747-400 4.5 bay hangar	
Messier Services	Singapore	NA	
Pratt & Whitney	Various	NA	
Shandong Taikoo	China	NA	
Shenyang Kaite	China	NA	
SIA Engineering	Singapore	155,100 sf	
Sichuan Aero	China	75,900 sf	
Singapore Technologies	Singapore	177,576 sf	
Taikoo Aircraft	China	924,000 sf	
Thai Airways	Thailand	47,520 sf	
Xinjiang Airlines	China	105,600 sf	
Yunnan Airlines	China	26,400 sf	
TOTAL REPORTED SF		3,635,479 sf	100%
	China	1,362,135 sf	37%
	Japan	693,000 sf	19%
	New Zealand	677,000 sf	19%
	Singapore	383,492 sf	11%
	Taiwan	187,166 sf	5%
	India	111,210 sf	3%
	Hong Kong	67,624 sf	2%
	United Arab Emirates (UAE)	53,882 sf	1%
	Saudi Arabia	52,470 sf	1%
	Thailand	47,520 sf	1%
Reported Facility Sizes:	< 50,000 sf	7	233,921 sf
	≥ 50,000 sf < 100,000 sf	5	300,692 sf
	≥ 100,000 sf < 500,000 sf	6	807,051 sf
	≥ 500,000 sf < 1,000,000 sf	3	2,294,000 sf
	≥ 1,000,000 sf	0	

APPENDIX C

Aircraft Maintenance Capacity In Europe

Firm	Country	Hangar Capacity
Aeroflot	Russia	NA
Aeronavali	Italy	287,100 sf
Aeroplex	Hungary	44,220 sf
Air France	France	1,372,800 sf
Alitalia Engineering	Italy	2,310,000 sf
AC Lasham	UK	160,000 sf
Atitech	Italy	1,057,548 sf
ASL Aircraft	Germany	132,000 sf
Aviakor	Russia	NA
Aviastar	Russia	NA
BAE Systems	UK	103,290 sf
Belavia Aircraft	Belarus	NA
Braathens Engineering	Norway	38,600 sf
Bykovo Aviation	Russia	NA
Cargolux Airlines	Luxembourg	8,500 sf
Celsius Aviacomp	Netherlands	9,900 sf
Condor/Cargo	Germany	NA
CRMA	France	NA
Dalavia Aviation	Russia	NA
Donavia Remont	Russia	66,000 sf
EADS EFW	Germany	85,140 sf
EADS Sogerma	France	NA
Eastline-Domododovo	Russia	66,000 sf
FLS Aerospace	Ireland	451,008 sf
Fokker Services	Netherlands	52,800 sf
GE Engine Services	Various	NA
Globalia Mantenimiento	Spain	8,910 sf
Icelandair	Iceland	41,250 sf
Jet Aviation	Various	560,371 sf
KAPO-Kazan	Russia	NA
KLM Engineering	Netherlands	257,948 sf
Lufthansa A.E.R.O.	Germany	13,002 sf
Lufthansa Shannon	Ireland	NA
Lufthansa Technik	Germany	1,247,400 sf
Marshall Aerospace	UK	1,200,000 sf
Martinair Holland	Netherlands	41,415 sf
Messier Services	France/UK	NA
Mineralnie Vodi	Russia	NA
Monarch Aircraft	UK	NA
Motor Sich	Ukraine	NA
MTU Maintenance	Germany	NA
Orzhansk Avairemont	Belarus	NA
Perm Motor	Russia	NA
Pratt & Whitney	Various	NA
Pulkovo Aviation	Russia	NA
Rolls Royce Aero	UK	NA
Rybinsk Motors	Russia	NA
Sabena Technics	Belgium	198,000 sf
Saratov Aviation	Russia	NA
SAS Component	Denmark	NA
Shannon Aerospace	Ireland	105,600 sf
Shannon MRO	Ireland	64,000 sf
Sibir Airlines	Russia	33,660 sf
Snecma Sabena	Belgium	NA
SR Technics	Switzerland	412,000 sf
TAP Air Portugal	Portugal	86,790 sf
TAT Industries	France	52,800 sf
Transaero	Russia	NA

Uzbekistan Airways	Uzbekistan	61,776 sf	
Varz 400	Russia	NA	
VASO	Russia	NA	
Viva Air	Spain	7,920 sf	
Volvo Aero	Sweden	NA	
Ykaterinburg Engine	Russia	NA	
TOTAL REPORTED SF		10,637,748 sf	100%

European Capacity By Nation:

Italy	3,654,648 sf	34%
Germany	1,477,542 sf	14%
UK	1,463,290 sf	14%
France	1,425,600 sf	13%
Ireland	620,608 sf	6%
Various	560,371 sf	5%
Switzerland	412,000 sf	4%
Netherlands	362,063 sf	4%
Belgium	198,000 sf	2%
Russia	165,660 sf	1%
Portugal	86,790 sf	0.8%
Uzbekistan	61,776 sf	0.6%
Hungary	44,220 sf	0.4%
Iceland	41,250 sf	0.4%
Norway	38,600 sf	0.3%
Spain	16,830 sf	0.1%
Luxembourg	8,500 sf	0.1%

Reported Facility Sizes:	< 50,000 sf	15	315,428 sf
	≥ 50,000 sf < 100,000 sf	11	719,236 sf
	≥ 100,000 sf < 500,000 sf	10	2,415,336 sf
	≥ 500,000 sf < 1,000,000 sf	0	0 sf
	≥ 1,000,000 sf	5	7,187,748 sf

APPENDIX D

Maintenance Capacity By Aircraft Type In The Americas:

Airbus

Aeroman	118,000 sf	
Air Canada	396,000 sf	
American Airlines	2,781,000 sf	
Aviation Management	800,000 sf	
Avtel	75,000 sf	
Dee Howard	850,000 sf	
EADS	1,200,000 sf	
GE Engine Services	NA	
Goodrich Aviation	1,000,000 sf	
Pemco	521,000 sf	
ST Mobile Aerospace	527,000 sf	
Timco	NA	
United Services	NA	
TOTAL	8,268,000 sf	
TOTAL of Americas Capacity Airbus Capable:		50%

Boeing/McDonnell Douglas

AAR Aircraft	99,000 sf	
Aeroman	118,000 sf	
Aero Mexico	2,147,336 sf	
Air Canada	396,000 sf	
American Airlines	2,781,000 sf	
Avborn	226,000 sf	
Aviation Management	800,000 sf	
Avtel Services	75,000 sf	
Boeing Airplane Services	500,000 sf	
Cascade Aerospace	250,000 sf	
Commodore Aviation	50,000 sf	
Coopesa	26,367 sf	
Dalfort Aerospace	140,000 sf	
Dee Howard	850,000 sf	
Delta TechOps	2,700,000 sf	
Evergreen Air	60,000 sf	
First Air	100,000 sf	
GE Engine	NA	
Goodrich Aviation	1,000,000 sf	
Hamilton Aviation	94,000 sf	
LanChile	17,820 sf	
Pemco	521,000 sf	
Seman Peru	71,775 sf	
Spar Aerospace	500,000 sf	
Stambaugh	78,000 sf	
ST Mobile	527,000 sf	
Timco	NA	
United Services	NA	
Varig Engineering	50,820 sf	
TOTAL of Americas Capacity Boeing/DC Capable:	14,179,118	85%

Americas Continued:

Other	AeroThrust	NA	
Aircraft	Air Atlantic	24,000 sf	
Types	AVMAX Group	50,000 sf	
	Dallas Airmotive	17,400 sf	
	Messier	NA	
	Middle River	1,400,000 sf	
	MTU Maintenance	NA	
	Patriot Aviation	8,000 sf	
	Piedmont Hawthorne	151,000 sf	
	Pratt & Whitney	NA	
	Texas Aero	450,000 sf	
	Wood Group	NA	
	TOTAL	2,100,400 sf	13%

APPENDIX E

Maintenance Capacity By Aircraft Type In Asia, Africa, Middle East, Oceania

Airbus	Air-India	111,210 sf		
	Ansett Australia	677,000 sf		
	China Aircraft	NA		
	China Airlines	141,900 sf		
	China Eastern	36,600 sf		
	China Northern	21,635 sf		
	China Northwest	11,550 sf		
	Evergreen	45,266 sf		
	Gangzhou Aircraft	41,950 sf		
	Gulf Aircraft	53,882 sf		
	Hong Kong Aircraft	67,624 sf		
	Korean Air	NA		
	Shandong Taikoo	NA		
	SIA Engineering	155,100 sf		
	Singapore Technologies	177,576 sf		
	Taikoo Aircraft	924,000 sf		
	Thai Airways	47,520 sf		
	TOTAL Asia, etc. Capacity Airbus Capable:	2,512,813	69%	
Boeing/DC	Air Asia	183,181 sf		
	Air India	111,210 sf		
	Alsalam Aircraft	52,470 sf		
	Ameco-Beijing	115,500 sf		
	Ansett Australia	677,000 sf		
	Bedek Aviation	NA		
	China Aircraft	NA		
	China Airlines	141,900 sf		
	China Southwest	NA		
	Evergreen	45,266 sf		
	Gangzhou	41,950 sf		
	Gulf	53,882 sf		
	Hong Kong Aircraft	67,624 sf		
	Japan Airlines	693,000 sf		
	Korean Air	NA		
	Shandong	NA		
	SIA	155,100 sf		
	Singapore Technologies	177,576 sf		
	Taikoo	924,000 sf		
	Thai Airways	47,520 sf		
	Xinjiang Airlines	105,600 sf		
	Yunnan Airlines	26,400 sf		
TOTAL Asia, etc. Capacity Boeing/DC Capable:	3,619,179	99%		

APPENDIX F

Maintenance Capacity By Aircraft Type In Europe

Airbus	Aeroflot	NA		
	Aeroplex of Central Europe	44,220 sf		
	Air France	1,372,800 sf		
	Alitalia	2,310,000 sf		
	Atitech	1,057,548 sf		
	ASL Aircraft	132,000 sf		
	BAE Systems	103,290 sf		
	Celsius Aviacomp	9,900 sf		
	EADS EFW	85,140 sf		
	EADS Sogerma	NA		
	Finnair	NA		
	FLS Aerospace	451,008 sf		
	Iberia Airlines	165,000 sf		
	Lufthansa Technik	1,247,400 sf		
	Marshall Aerospace	1,200,000 sf		
	Messier	NA		
	Monarch Aircraft	NA		
	Sabena Technics	198,000 sf		
	Shannon Aerospace	105,600 sf		
	SR Technics	412,000 sf		
	TAP Air Portugal	86,790 sf		
	Uzbekistan Airways	61,776 sf		
	TOTAL European Capacity Airbus Capable:	9,051,472 sf	85%	

Boeing/DC	Aeroflot	NA
	Aeronavali	287,100 sf
	Aeroplex	44,220 sf
	Air France	1,372,800 sf
	Alitalia	2,310,000 sf
	ATC Lasham	160,000 sf
	Atitech	1,057,548 sf
	Braathens Engineering	39,600 sf
	Cargolux	8,500 sf
	Celsius Aviacomp	9,900 sf
	Condor/Cargo	NA
	Finnair	NA
	FLS Aerospace	451,008 sf
	Fokker Services	52,800 sf
	Globalia Mantenimiento	8,910 sf
	Iberia Airlines	165,000 sf
	Icelandair	41,250 sf
	KLM Engineering	257,948 sf
	Lufthansa Technik	1,247,400 sf
	Marshall Aerospace	1,200,000 sf
	Martinair Holland	41,415 sf
	Messier	NA
	Monarch Aircraft	NA
	Sabena Technics	198,000 sf
	SAS Component	NA
	Shannon Aerospace	105,600 sf
	Shannon MRO	64,000 sf
	SR Technologies	412,000 sf
	TAP Air Portugal	86,790 sf

TAT Industries	52,800 sf
Transaero	NA
Uzbekistan Airways	61,776 sf
Viva Air	7,920 sf
TOTAL European Capacity Boeing/DC Capable:	9,744,285 sf 92%

APPENDIX G

Employment Statistics for the Aircraft Maintenance Industry:

North and South America

Employment	88,000	
Number of Firms	42	
Largest	United Services	15,800
	GE Engine Services	11,300
	Delta TechOps	11,000
	American Airlines	9,000
	Air Canada Technical Services	8,000
	Pratt & Whitney	5,500
	Timco	4,000
	Varig Engineering & Maintenance	3,570
	Boeing Airplane Services	2,800
	Goodrich Aviation Services	2,600
	LanChile S.A.	1,500
	Dallas Airmotive	1,450
	Seman Peru	1,350

Cited As “Fastest Growing Business Segments”

11 firms cited heavy Maintenance
Cargo Conversions was cited by 3 firms
3 firms cited Engine/component overhaul
Regional Airlines, Interior Modifications, VIP Completions each
were cited by one firm

Number of firms indicating maintenance capability for Airbus:

14 (12 in US)

APPENDIX H

Aircraft maintenance employment in Asia, Africa, Middle East, Oceania

Employment	46,973	
Number of Firms	31	
Largest	ANNZES	4,600
	SIA Engineering	4,301
	Air-India Ltd.	3,670
	Japan Airlines Co., Ltd.	3,639
	Korean Air	3,600
	Ameco-Beijing	3,000
	Bedek Aviation Group	2,900
	Hong Kong Aircraft Engineering	2,510
	Guangzhou Aircraft Maintenance	2,300
	China Airlines	2,170
	Taikoo (Xiamen) Aircraft	2,033
	Sichuan Aero Engine Maint.	2,100
	China Eastern Airlines	1,620
	Singapore Technologies	1,455
	Evergreen Aviation Technologies	1,700
	China Northwest Airlines	1,008
	Thai Airways International	1,000

Cited As Fastest Expected Growth Segments:

Heavy Maintenance: Five Firms

Engine/Component Repair: Four Firms

Aircraft Overhaul, Conversions, and Airbus Fleet were each cited once

Number of firms citing Airbus Maintenance Capability: 18

APPENDIX I

Aircraft Maintenance Employment Statistics for Europe

Employment	74,008
Number of Firms	63
Largest	Air France Industries 10,000
	Lufthansa Technik AG 10,000
	KLM Engineering & Maintenance 5,000
	Iberia Airlines of Spain 4,000
	Alitalia Engineering 4,000
	FLS Aerospace 3,500
	Jet Aviation 3,500
	EADS Sogerma Services 2,633
	Sabena Technics 2,610
	Rolls Royce Aero 2,300
	Finnair 2,200
	SR Technics 2,200
	Varz 400 2,200
	TAP Air Portugal 2,006
	Belavia Remont-Minsk 2,000
	Uzbekistan Airways 2,000
	Donavia Remont 1,950
	Aeronavali 1,700
	Marshall Aerospace 1,600
	Yekaterinburg Engine 1,200
	MTU Maintenance 1,050

Cited As Fastest Expected Growth Segments:

Heavy Maintenance: Eight Firms

Airbus: Five Firms

Conversions: Two Firms

Number of firms citing Airbus Maintenance Capability: 22