The Relationship between an Aircraft's Value and its Maintenance Status

Theory of Aircraft Maintenance Adjusted Valuations

By: Mr. Shannon Ackert

Abstract

Aircraft market values are influenced by a host of determinants, and key among them is its maintenance status. Maintenance status is directly linked to maintenance value and, depending on the age of the aircraft, can account for a significant portion of a modern aircraft's market value. However, the impact of maintenance status is rarely constant. Similar to aircraft values, maintenance status values are highly influenced by market conditions; values naturally decline in a recession and rise again as the industry recovers.

Maintenance status is also determined by the manner in which an aircraft operates. The rate of deterioration of high cost maintenance events (i.e. engine restoration and LLP replacement) is affected by several factors such as average flight length and region of operation. Lastly, the effects of both labor and material inflation are key drivers of escalating maintenance costs and therefore efforts should be taken to account for these variables when forecasting future maintenance exposure.

The material presented herein is intended to be both a guide and a resource tool for those interested in gaining a better understanding of the determinants that impact maintenance status, and to point out how an aircraft's maintenance status can influence its market value.

The Relationship between an Aircraft's Value and its Maintenance Status

Theory of Aircraft Maintenance Adjusted Valuations

TABLE OF CONTENTS

1.0 INTRODUCTION

One of the fundamental factors to be considered when valuing an aircraft is the condition of its maintenance status. The sometimes wide disparity between appraisals for similarly aged aircraft can often be explained by differences in their maintenance condition. Therefore, where possible it is useful to quantify in monetary terms the maintenance status of aircraft involved in transactions given a strong relationship exists between the cost of conducting maintenance and value enhancement.

The vast majority of aircraft appraisers and traders quantify the value of an aircraft's maintenance status through analysis of certain, high cost major maintenance events. These events generally consist of: a.) Airframe heavy check (heavy structural inspection); b.) Engine performance restoration & LLP replacement; c.) Landing gear overhaul; and d.) APU performance restoration.

Maintenance value is also heavily influenced by market forces. In surplus conditions, where aircraft values tend to command premium prices, prospective buyers are more willing to consider aircraft in lesser maintenance condition. Conversely, buyers are reluctant to expend cash on aircraft with lower levels of maintenance status, and quite often such conditions will warrant scrapping and/or parting out of the aircraft. Lastly, the cost of maintenance is also influenced by ever increasing inflation, which over the long-term has the potential make an aircraft uneconomical to operate.

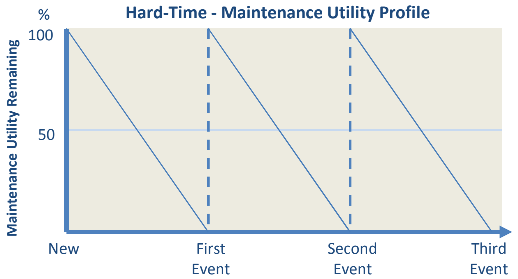
2.0 MAINTENANCE UTILITY

To underpin the depreciation profile associated with the maintenance events highlighted above we need to relate the maintenance utility profile that each event is attributed to. This requires an understanding of the factors that influence each maintenance events time on-wing characteristics in addition to the factors that influence its costs.

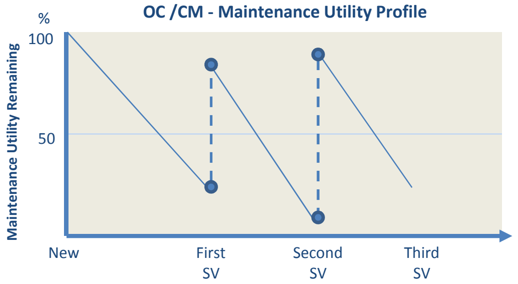
The maintenance utility profile for hard-time and on-condition/condition-monitored events follow a conventional saw-tooth maintenance cycle as illustrated in Figure 1 below. Maintenance value declines with time on-wing, however, depending on the nature of the maintenance event, the value may or may not fully amortize to zero nor does it fully re-capitalize to 100% of its market value.

In general, maintenance events that are subject to a hard-time interval (i.e. airframe heavy checks and landing gear overhauls) have their corresponding values decline to zero and subsequently recapitalized to full value after each check. On the other hand, on-condition and condition-monitored maintenance events, such as engine shop visits, rarely have their maintenance value fully exhausted during a shop visit.

FIGURE 1 – EXAMPLE SAW-TOOTH MAINTENANCE UTILITY PROFILES



Maintenance events subject to **hard-time** intervals follow a conventional saw-tooth curve whereby one can expect 100% of its maintenance utility to be recovered following each event. It's a fairly straightforward process to calculate deviations from half-life if a maintenance event is under a hard-time interval.



On-condition (OC) & **condition-monitored (CM)** maintenance events can be difficult to assess given 100% of their maintenance utility is rarely consumed. Additionally, the workscope will often only partially restore the value it lost.

3.0 MAINTENANCE STATUS

Maintenance status is used to assess, in whole or part, the value of maintenance utility remaining. The value of maintenance status can be assessed by analyzing data related to an aircraft's maintenance condition at a specific point in time. The key to quantifying maintenance status lies in making accurate assessment as to: 1.) Where each major maintenance event is relative to their last and next shop visit, and 2.) What percentage of its next shop visit cost is remaining.

Depending on the aircraft type and age, the value of maintenance status can represent a significant proportion of an aircraft's overall market value. Where appraisers are responsible for ascertaining the market value of an aircraft, they use, as a baseline reference, two industry-standard terms to represent an aircraft's maintenance status. These terms consist of full-life and half-life.

3.1 Full-life – The full-life status implies that each major maintenance event has just been fully restored or overhauled to zero time condition; the airframe is fresh from its heavy check, the landing gear is fresh from an overhaul, the engines are fresh from a performance-restoration shop visit, and all engine Life Limited Parts (LLPs) have zero-life used.

Such a program of maintenance is practically impossible nevertheless full-life status does denote a reference value representing the cost of returning each major maintenance event to full life condition. For example, the cost of taking an A320-200 from zero-life to full-life is in excess of $11 million dollars.

3.2 Half-life – The half-life status assumes that the airframe, engines, landing gear and all major components are half-way between major overhauls and that any life-limited part (for example an engine disk) has used up half of its life. Figure 2 illustrates the full & half-life maintenance status for a new A320 aircraft.

FIGURE 2- EXAMPLE: A320-200 FULL-LIFE & HALF-LIFE MAINTENANCE STATUS & VALUES

Aircraft:	Base Year: 2011	OPERATIONAL PROFILE	Annual FH:	Flight Leg:	Eng Derate:	Region:
A320-200			3,600	1.8	10%	Temperate

A320-200 FULL & HALF-LIFE VALUATION

Equipment	Event	Phase	Unit Cost	Units	Full-life Value	Half-life Value	Full-life Mtx Intervals Mo	Full-life Mtx Intervals FH	Full-life Mtx Intervals FC	Half-life Mtx Intervals Mo	Half-life Mtx Intervals FH	Half-life Mtx Intervals FC
Airframe	4C/6Y SI	First-Run	780,000	1	780,000	390,000	72			36		
Airframe	8C/12Y SI	First-Run	850,000	1	850,000	425,000	144			72		
Landing Gear	Gear Ovhl		420,000	1	420,000	210,000	120		20,000	60		10,000
APU	APU Rest		265,000	1	265,000	132,500		7,500 [1]			3,750	
Eng Modules	Eng Rest	First-Run	2,235,000	2	4,470,000	2,235,000		24,300	13,500		12,150	6,750
Eng LLPs	Eng LLP		2,170,000	2	4,340,000	2,170,000			23,000 [2]			11,500
Totals					**11,125,000**	**5,562,500**						

[1] APU FH
[2] Weighted average

Maintenance Status Perspective

In the real world it is common to make financial adjustments to account for both the condition and maintenance status of an aircraft. This often involves performing a physical inspection or conducting a thorough review of its technical records.

Condition tends to be more of a judgment call. If an aircraft has a lot scab patches, is dirty, is dripping fluids, and has a lot of deferred maintenance items, it is not uncommon to assign a lower value to this aircraft. In most cases however, an aircraft's condition, as opposed to its maintenance status, would not warrant a significant change in an appraiser's standard value opinion.

4.0 MONITORING MAINTENANCE STATUS

Adjustments from half-life are computed based on maintenance status information compiled from aircraft technical specification sheets. Adjustments are calculated only when there is sufficient information to do so, or where reasonable assumptions can be made. Figure 3 below illustrates an example of a maintenance status report for a Jan-2006 build A320 aircraft, and which was recorded on Jan-2011.

Figure 3- Example A320-200 Maintenance Status Information

AIRCRAFT MAINTENANCE STATUS AS OF :		15-Jan-11							
Aircraft :	A320-200				TSN	CSN			
Date Mfg :	15-Jan-06			Aircraft:	18,000 FH	10,000 FC			
				Eng Pos 1:	18,000 FH	10,000 FC			
Utilization:	3,600 FH	2,000 FC		Eng Pos 2:	18,000 FH	10,000 FC			
Maint	Maint	-------- Recommended Intervals ---------			------------- Maintenance Status Since New / Last Check -------------				
Equipment	Event	Months	FH	FC	Performed	FH	FC	Months	Remaining
Airframe	4C/6YR SI	72			15-Jan-06			60 Mo	12 Mo
	8C/12YR SI	144			15-Jan-06			60 Mo	84 Mo
Ldg Gear	Overhaul	120		20,000	15-Jan-06			60 Mo	60 Mo
APU	Restoration	On-Condition / MTBPR = 7,500 APU FH				5,850 APU FH			1,650 APU FH
Eng Pos 1	Restoration	On-Condition / MTBPR = 13,500 FC			15-Jan-06		10,000 FC		3,500 FC
Eng Pos 2	Restoration				15-Jan-06		10,000 FC		3,500 FC
LLP STATUS				**ENGINE POSITION 1**			**ENGINE POSITION 2**		
LLP	LLP $	FC Limit	$/FC	Current FC	Remain FC	Remain $	Current FC	Remain FC	Remain $
1	150,000	30,000	5.00	10,000	20,000	100,000	10,000	20,000	100,000
2	150,000	30,000	5.00	10,000	20,000	100,000	10,000	20,000	100,000
3	150,000	30,000	5.00	10,000	20,000	100,000	10,000	20,000	100,000
4	130,000	20,000	6.50	10,000	10,000	65,000	10,000	10,000	65,000
5	130,000	20,000	6.50	10,000	10,000	65,000	10,000	10,000	65,000
6	130,000	20,000	6.50	10,000	10,000	65,000	10,000	10,000	65,000
7	130,000	20,000	6.50	10,000	10,000	65,000	10,000	10,000	65,000
8	130,000	20,000	6.50	10,000	10,000	65,000	10,000	10,000	65,000
9	130,000	20,000	6.50	10,000	10,000	65,000	10,000	10,000	65,000
10	130,000	20,000	6.50	10,000	10,000	65,000	10,000	10,000	65,000
11	130,000	20,000	6.50	10,000	10,000	65,000	10,000	10,000	65,000
12	130,000	20,000	6.50	10,000	10,000	65,000	10,000	10,000	65,000
13	130,000	25,000	5.20	10,000	15,000	78,000	10,000	15,000	78,000
14	84,000	25,000	3.36	10,000	15,000	50,400	10,000	15,000	50,400
15	84,000	25,000	3.36	10,000	15,000	50,400	10,000	15,000	50,400
16	84,000	25,000	3.36	10,000	15,000	50,400	10,000	15,000	50,400
17	84,000	25,000	3.36	10,000	15,000	50,400	10,000	15,000	50,400
18	84,000	25,000	3.36	10,000	15,000	50,400	10,000	15,000	50,400
Totals :	**2,170,000**	**420,000**	**95.50**		**240,000**	**1,215,000**		**240,000**	**1,215,000**
Remain :					**57.1%**	**56.0%**		**57.1%**	**56.0%**

4.1 Engine Maintenance Status – The modern trend is to maintain engines on an on-condition monitoring basis, wherein engines are removed only when an internal component reaches its individual life limit, or when performance monitoring suggests that the engine is operating outside manufacturers suggested parameters.

In order to monitor the performance of an engine, regular detailed measurements are taken of the engine's operating speed, temperature, pressure, fuel flow and vibration levels. The measurements are tracked by special software in order to identify deteriorating trends. By closely monitoring these trends it is possible to make accurate predictions as to when an engine's scheduled removal is warranted, and by correlation, the interval remaining to its next shop visit.

5.0 QUANTIFYING MAINTENANCE STATUS

Half-life is also standard appraisal industry term to indicate that no value adjustment has been made for the actual maintenance status of the aircraft – the assumption being that the airframe, engines (modules & LLPs), landing gear, and other major maintenance events are in half-life status. Half-life thus enables a comparison to be made between values of aircraft of different types and ages using a common denominator. It does not indicate that the aircraft is half-way through its useful life.

An aircraft's half-life adjustment value can be quantified using the following equation:

Adjustment from Half-Time = (Mtx Event % Life Remaining – 50%) * (Mtx Event Cost)

The following examples illustrate the calculations of adjustment from half-life for a Jan-2006 build A320 aircraft as of Jan-2011, based on an assumed annual utilization of 3,600 FH and 2,000 FC.

Example A: Calculation of adjustment from half-life for the 4C/6Year Structural Inspection:

- 4C/6Year Event Interval = 72 months
- Average Maintenance Event Cost = $780,000
- Life Remaining =12 months
- % Life Remaining = 12/72 = 16.67%

Solution A: Adjustment from Half-Time = (16.67% - 50%)*$780,000 = ($260,000)

Example B: Calculation of adjustment from half-life for all major maintenance events.

SOLUTION B:

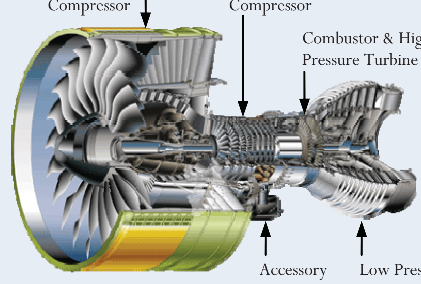
AIRCRAFT MAINTENANCE STATUS AS OF :	15-Jan-11				
Aircraft :	A320-200			TSN	CSN
Date Mfg :	15-Jan-06		Aircraft:	18,000 FH	10,000 FC
			Eng Pos 1:	18,000 FH	10,000 FC
Utilization:	3,600 FH	2,000 FC	Eng Pos 2:	18,000 FH	10,000 FC

Mtx Equipment	Mtx Event	Mtx Phase	Mtx Cost $	Mtx Interval	Interval Remain	Life Remaining % Total	Life Remaining % 1/2 Time	Adjust From 1/2 Time $
ADJUSTMENT FROM HALF TIME CALCULATION								
Airframe	4C / 6YR SI	First-Run	780,000	72 Mo	12 Mo	16.7%	-33.3%	(260,000)
Airframe	8C / 12YR SI	First-Run	850,000	144 Mo	84 Mo	58.3%	8.3%	70,833
Landing Gear	Overhaul		420,000	120 Mo	60 Mo	50.0%	0.0%	0
APU	Perf Rest		265,000	7,500 APU FH	1,650 APU FH	18.0%	-32.0%	(84,800)
Engine Position 1	Perf Rest	First-Run	2,235,000	13,500 FC	3,500 FC	25.9%	-24.1%	(538,056)
Engine Position 1	LLP Replace		2,170,000	Limiter		56.0%	6.0%	130,000
Engine Position 2	Perf Rest	First-Run	2,235,000	13,500 FC	3,500 FC	25.9%	-24.1%	(538,056)
Engine Position 2	LLP Replace		2,170,000	Limiter		56.0%	6.0%	130,000
Half-Life Adjustment :			**11,125,000**					**(1,090,078)**

Engine Maintenance Status Perspective

Unlike airframes, engines are highly modular. That means they are broken down into several large sub parts (modules), for ease of maintenance. Modules are:

- Frequently swapped between engines, and are
- Tracked independently, each subject to an individual overhaul life, with its own service bulletins, airworthiness directives, and inspection thresholds for condition-monitoring.



6.0 FORECASTING MAINTENANCE STATUS

Developing fair and accurate assessments of an aircraft's future maintenance status requires an understanding of the factors that influence the Direct Maintenance Costs (DMC) of each major maintenance event. These influencing factors consist of the: 1) Aircraft operation, 2) Aircraft age, and 3) Maintenance inflation.

6.1 Aircraft Operation – To accurately forecast maintenance status it's important to consider the type of operation the aircraft will be exposed to. An aircraft's maintenance value will amortize based on the DMC profile associated with its specific operational profile. The same model aircraft operating at different profiles will experience different levels of DMC. The key operational factors influencing an aircraft's DMC are: 1.) Flight length, 2.) Engine derate, and 3.) Operating environment. Figure 4 below illustrates the variations in DMC taking into consideration differences in flight leg, derate, and region of operation.

1. Flight length – The impact of lower flight length results in higher cyclic loads on an airframe's structure with the consequence of higher non-routine maintenance. Smaller flight segments also force engines to spend a larger proportion of total flight time using take-off and climb power settings resulting in more rapid performance deterioration, which translates to higher DMC. Conversely, longer sector lengths will lead to less wear & tear on the airframe and engines, and a commensurate decrease in DMC per flight hour.
2. Engine derate - Take-off derate thrust is a thrust setting that is below the maximum thrust level. A larger derate translates into lower take-off EGT, resulting in lower engine deterioration rate, longer on-wing life, and reduced DMC.
3. Operating environment – More caustic operating environments generally result in higher engine DMC. Engines operating in dusty, sandy and erosive-corrosive environments are exposed to higher blade distress and thus greater performance deterioration. Particulate material due to air pollution, such as dust, sand or industry emissions can erode HPC blades and block HPT vane/blade cooling holes. Other environmental distress symptoms consist of hardware corrosion and oxidation.

FIGURE 4 – A320-200 - OPERATIONALLY ADJUSTED DIRECT MAINTENANCE COSTS (DMC) / BASE YEAR: 2011

The more severe the operating profile, the greater the DMC, all else equal.

Aircraft: A320-200

OPERATIONAL PROFILE — Annual FH: 3,600 | Flight Leg: 1.8 | Eng Derate: 10% | Region: Temperate

A320-200 FIRST-RUN DIRECT MAINTENANCE COSTS (DMC $/FH)

Equipment	Event	Phase	Unit Cost	Units	Full-life Value	Half-life Value	Monthly Min $	Operating Rate	DMC $/FH	DMC $/MO
Airframe	4C/6Y SI	First-Run	780,000	1	780,000	390,000	10,830	36.10 / FH	36.10	10,830
Airframe	8C/12Y SI	First-Run	850,000	1	850,000	425,000	5,900	19.70 / FH	19.70	5,910
Landing Gear	Gear Ovhl		420,000	1	420,000	210,000	3,500	21.00 / FC	11.67	3,500
APU	APU Rest		265,000	1	265,000	132,500		35.00 / APU FH	23.00	6,900
Eng Modules	Eng Rest	First-Run	2,235,000	2	4,470,000	2,235,000		92.00 / FH	184.00	55,200
Eng LLPs	Eng LLP		2,170,000	2	4,340,000	2,170,000		94.50 / FC	105.00	31,500
Totals					**11,125,000**	**5,562,500**			**380.00**	**113,840**

OPERATIONAL PROFILE — Annual FH: 3,600 | Flight Leg: 1.2 | Eng Derate: 15% | Region: Hot / Dry

A320-200 FIRST-RUN DIRECT MAINTENANCE COSTS (DMC $/FH)

Equipment	Event	Phase	Unit Cost	Units	Full-life Value	Half-life Value	Monthly Min $	Operating Rate	DMC $/FH	DMC $/MO
Airframe	4C/6Y SI	First-Run	780,000	1	780,000	390,000	10,830	36.10 / FH	36.10	10,830
Airframe	8C/12Y SI	First-Run	850,000	1	850,000	425,000	5,900	19.70 / FH	19.70	5,910
Landing Gear	Gear Ovhl		420,000	1	420,000	210,000	3,500	21.00 / FC	17.50	5,250
APU	APU Rest		265,000	1	265,000	132,500		35.00 / APU FH	23.00	6,900
Eng Modules	Eng Rest	First-Run	2,191,500	2	4,383,000	2,191,500		103.20 / FH	206.40	61,920
Eng LLPs	Eng LLP		2,170,000	2	4,340,000	2,170,000		94.50 / FC	157.50	47,250
Totals					**11,038,000**	**5,519,000**			**460.00**	**138,060**

6.2 Aircraft Age - As an aircraft matures, subsequent airframe heavy checks are expected to incur substantially higher non-routine tasks, and engines in particular, will incur higher maintenance costs following its honeymoon phase – defined as the period of time leading up to its first performance restoration.

Therefore, when forecasting maintenance costs it's critical to adjust these expenses to account for the age (or maturity) of the applicable maintenance event. For a given aircraft, the aging cycle will generally be broken into three phases consisting of: first-run, mature-run, and aging-run.

1. First-Run is the initial operating years, often referred to as the honeymoon period. The structure, systems, and components are new; and there is less non-routine maintenance and material scrap rate. From a maintenance cost perspective, newness is generally considered the first 4-6 years of in-service operation.

2. Mature-Run begins after the newness phase and runs through the first maintenance cycle. This period typically falls between the first heavy maintenance visit and the second maintenance visit.

3. Aging-Run begins after the end of the first maintenance cycle when the effects of airframe age result in higher non-routine maintenance costs. This period typically begins after the second heavy maintenance visit and continues to increase with time.

Figure 5 below illustrates the range of DMCs based on the aging profile of an A320-200 aircraft operating under a common profile.

FIGURE 5 – A320-200 - AGE RELATED DIRECT MAINTENANCE COSTS (DMC) / BASE YEAR: 2011

AIRCRAFT	OPERATIONAL PROFILE			
Aircraft :	Annual FH :	Flight Leg :	Eng Derate :	Region :
A320-200	3,600	1.8	10%	Temperate

First-Run Phase : New – 6 Years

Equipment	Event	Phase	Unit Cost	Units	Full-life Value	Half-life Value	Monthly Min $	Operating Rate	DMC $ / FH	DMC $ / MO
Airframe	4C/6Y SI	First-Run	780,000	1	780,000	390,000	10,830	36.10 / FH	36.10	10,830
Airframe	8C/12Y SI	First-Run	850,000	1	850,000	425,000	5,900	19.70 / FH	19.70	5,910
Landing Gear	Gear Ovhl		420,000	1	420,000	210,000	3,500	21.00 / FC	11.67	3,500
APU	APU Rest		265,000	1	265,000	132,500		35.00 / APU FH	23.00	6,900
Eng Modules	Eng Rest	First-Run	2,235,000	2	4,470,000	2,235,000		92.00 / FH	184.00	55,200
Eng LLPs	Eng LLP		2,170,000	2	4,340,000	2,170,000		94.50 / FC	105.00	31,500
Totals					**11,125,000**	**5,562,500**			**380.00**	**113,840**

Mature-Run Phase : 6 Years – 12 Years

Equipment	Event	Phase	Unit Cost	Units	Full-life Value	Half-life Value	Monthly Min $	Operating Rate	DMC $ / FH	DMC $ / MO
Airframe	4C/6Y SI	Mature-Run	897,000	1	897,000	448,500	12,460	41.50 / FH	41.50	12,450
Airframe	8C/12Y SI	First-Run	850,000	1	850,000	425,000	5,900	19.70 / FH	19.70	5,910
Landing Gear	Gear Ovhl		420,000	1	420,000	210,000	3,500	21.00 / FC	11.67	3,500
APU	APU Rest		265,000	1	265,000	132,500		35.00 / APU FH	23.00	6,900
Eng Modules	Eng Rest	Mature-Run	2,500,000	2	5,000,000	2,500,000		154.30 / FH	308.60	92,580
Eng LLPs	Eng LLP		2,170,000	2	4,340,000	2,170,000		94.50 / FC	105.00	31,500
Totals					**11,772,000**	**5,886,000**			**510.00**	**152,840**

Ageing Phase : > 12 Years

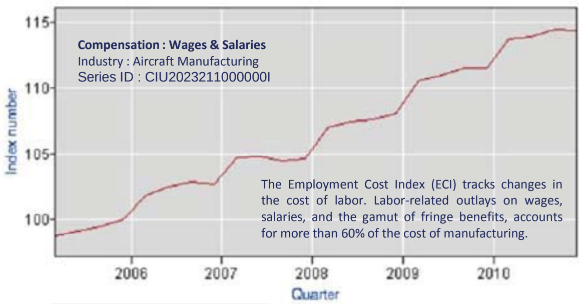
Equipment	Event	Phase	Unit Cost	Units	Full-life Value	Half-life Value	Monthly Min $	Operating Rate	DMC $ / FH	DMC $ / MO
Airframe	4C/6Y SI	Mature-Run	986,700	1	986,700	493,350	13,700	45.70 / FH	45.70	13,710
Airframe	8C/12Y SI	Mature-Run	1,020,000	1	1,020,000	510,000	7,080	23.60 / FH	23.60	7,080
Landing Gear	Gear Ovhl		420,000	1	420,000	210,000	3,500	21.00 / FC	11.67	3,500
APU	APU Rest		265,000	1	265,000	132,500		35.00 / APU FH	23.00	6,900
Eng Modules	Eng Rest	Mature-Run	2,500,000	2	5,000,000	2,500,000		154.30 / FH	308.60	92,580
Eng LLPs	Eng LLP		2,170,000	2	4,340,000	2,170,000		94.50 / FC	105.00	31,500
Totals					**12,031,700**	**6,015,850**			**520.00**	**155,270**

6.3 Maintenance Inflation – Maintenance inflation is affected by a number of factors, but the most obvious of these factors are increases in both wage and material costs. Engine manufacturers, in particular, escalate their piece-parts by a rate often exceeding the rate of inflation. In general, newer aircraft would experience deferred inflationary pressures given there is a considerable maintenance "honeymoon" period during which aircraft DMCs are below predicted mature levels. As an aircraft ages however, the effects of inflation often result in much higher labor and material costs, with the consequence of accelerating higher maintenance costs.

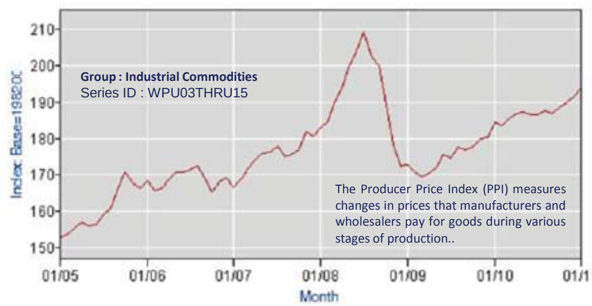
6.3.1 Applying Cost Indices to Forecast Maintenance Costs – The primary econometric parameters used to measure changes in cost over time (i.e. escalation) are cost indices. The Bureau of Labor Statistics (BLS) provides two basic types of indices that serve as a proxy for measuring changes in cost levels for both aircraft maintenance wages and aerospace materials. These indices are illustrated in Figure 6 and consist of: a.) Employment Cost Index (ECI) for aircraft manufacturing wages & salaries, and b.) Producer Price Index (PPI) for industrial commodities.

Source : BLS

FIGURE 6 – AIRCRAFT MAINTENANCE INFLATION INDICES



Year	Qtr1	Qtr2	Qtr3	Qtr4
2005	98.8	99.1	99.5	100.0
2006	101.9	102.5	102.9	102.7
2007	104.7	104.8	104.4	104.6
2008	107.0	107.4	107.6	108.1
2009	110.5	111.0	111.5	111.5
2010	113.7	113.9	114.5	114.4



Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	152.7	153.6	155.6	157.2	156.3	156.6	159.1	160.8	166.0	170.6	167.6	166.5
2006	168.3	165.7	166.3	168.8	170.6	170.6	171.3	172.4	169.2	165.4	168.0	168.9
2007	166.8	169.1	171.6	173.9	176.0	176.4	177.9	174.9	175.6	176.9	181.8	180.7
2008	182.8	184.6	190.2	193.8	200.0	204.0	209.5	202.4	200.1	189.3	178.4	172.3
2009	172.6	170.8	169.5	170.3	172.0	175.5	174.6	177.7	176.9	177.8	180.1(R)	180.4
2010	184.6	183.6	185.6	187.0	187.2	186.4	186.7	187.5	186.8	188.7(P)	189.7(P)	191.5(P)
2011	193.7(P)											

Methods that will allow one to estimate maintenance inflation rationally consist of assigning weights to each of the above indices to arrive at a generic multiplier. A general guideline for allocation of aircraft maintenance costs is a weighting consisting of 75% labor and 25% material. Referring to the respective indices above, one can approximate the constant dollar multiplier (P) over a five year period from Jan-2005 to Dec-2010, where (L) is labor and (M) is material, as follows:

$$P = 0.75*(L_{2010}/L_{2005}) + 0.25*(M_{2010}/M_{2005}) = .75*(114.4/98.8) + .25(191.5/152.7) = 1.182$$

Thus, over a period of 5 years maintenance inflation increased by 18.2%, which translates into an average annual escalation of 3.64%. However, it's worth noting that while an aircraft is new very little non-routine activity will occur, and labor & material cost escalations will not affect maintenance cost to the same degree as older aircraft.

The effects of inflation can be best observed by viewing its impact on an aircraft's full-life maintenance cost as illustrated in Figure 7, where a sustained inflation rate of 3% is expected to more than double a new A320's full-life maintenance value.

FIGURE 7 – A320 INFLATION ADJUSTED MTX VALUE

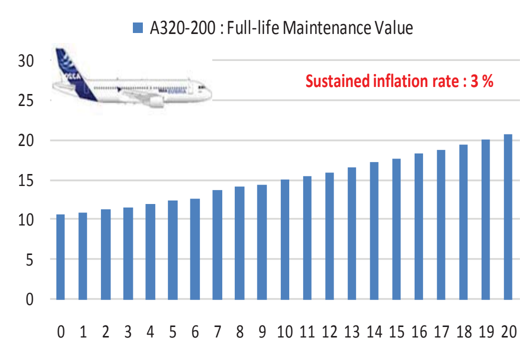


Figure 8 below illustrates an example of the half-life maintenance status forecast for a new 2011 build A320-200 aircraft taking into consideration the influence of the aircraft's operation, its age, and a sustained maintenance inflation rate of 3% per year. Chart A illustrates each major event's maintenance utility profile unadjusted for inflation. Chart B illustrates the consolidated maintenance status forecast along with projections for the aircraft's theoretical, inflation-adjusted half-life values during two phases of its economic life.

FIGURE 8 – A320-200 OPERATIONALLY ADJUSTED MAINTENANCE STATUS FORECAST

Chart A - Maintenance Status Forecast by Event – 2011 Constant Dollars

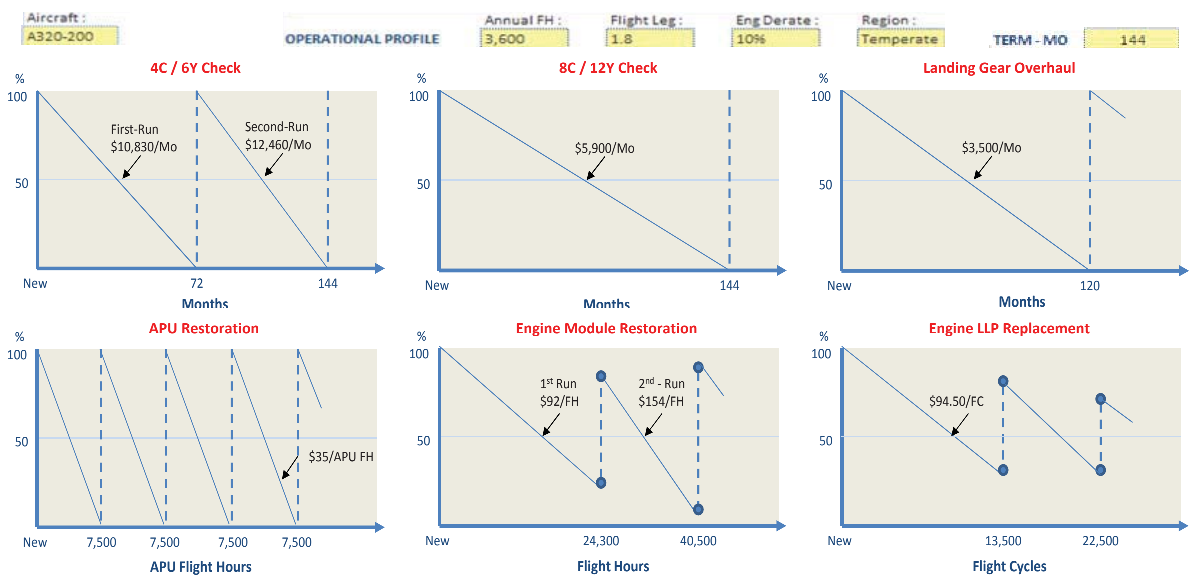
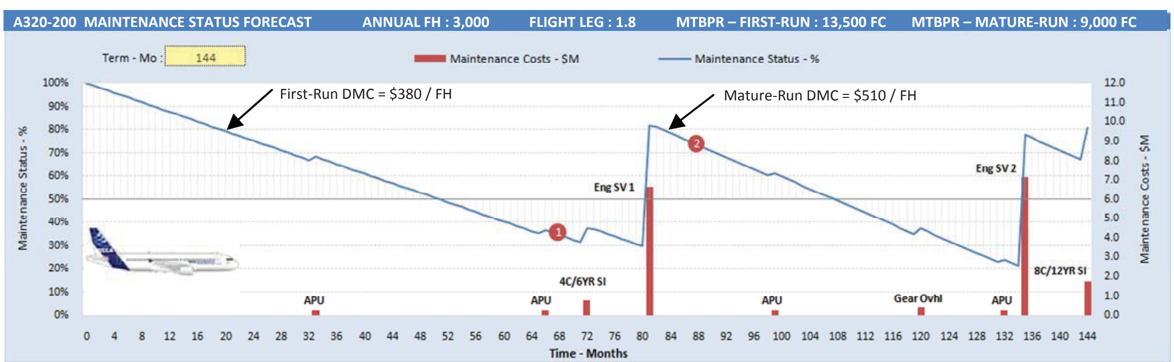


Chart B – Half-life Maintenance Status Forecast – 2011 Constant Dollars (See Source Data in Appendix 3)



Scenario 1 : Theoretical Maintenance Half-life Value @ Month 68

Event	Mtx Interval	Int Remain	% Remain	2011 Cost $	2017 Cost $	Half-Life $
4C/6YR SI	72 Months	4 Months	5.6%	780,000	931,398	(413,955)
8C/12YR SI	144 Months	76 Months	52.8%	850,000	1,014,985	28,194
Gear Ovhl	120 Months	52 Months	43.3%	420,000	501,522	(33,435)
Eng 1 PR 1	13,500 FC	2,170 FC	16.1%	2,235,000	2,668,814	(905,420)
Eng 1 LLP	Life Limit	12,266 FC	52.0%	2,170,000	2,591,197	51,165
Eng 2 PR 1	13,500 FC	2,170 FC	16.1%	2,235,000	2,668,814	(905,420)
Eng 2 LLP	Life Limit	12,266 FC	52.0%	2,170,000	2,591,197	51,165
APU PR	7,500 FH	6,500 FH	86.7%	265,000	316,437	116,027
				11,125,000	13,284,363	(2,011,678)

Scenario 2 : Theoretical Maintenance Half-life Value @ Month 88

Event	Mtx Interval	Int Remain	% Remain	2011 Cost $	2019 Cost $	Half-Life $
4C/6YR SI	72 Months	56 Months	77.8%	897,000	1,136,320	315,644
8C/12YR SI	144 Months	56 Months	38.9%	850,000	1,076,780	(119,642)
Gear Ovhl	120 Months	32 Months	26.7%	420,000	532,056	(124,146)
Eng 1 PR 2	9,000 FC	6,830 FC	85.4%	2,500,000	3,167,000	1,120,326
Eng 1 LLP	Life Limit	16,800 FC	71.2%	2,170,000	2,748,956	582,406
Eng 2 PR 2	9,000 FC	6,830 FC	85.4%	2,500,000	3,167,000	1,120,326
Eng 2 LLP	Life Limit	16,800 FC	71.2%	2,170,000	2,748,956	582,406
APU PR	7,500 FH	2,300 FH	30.7%	265,000	335,702	(64,902)
				11,772,000	14,912,770	3,412,418

7.0 AIRCRAFT VALUE DEFINITIONS

An aircraft's value means different things to different people. An accountant will think of it in terms of book value, or the value recorded in the ledger. An aircraft trader will consider it as the fair market value. The standard aircraft value terms used by the vast majority of aircraft appraisers are defined by the International Society of Transport Aircraft Trading (ISTAT). The following is a representative sample of key definitions that conform to the standards set forth by ISTAT.

7.1 Base Value - represents the opinion of the value of single aircraft in a single arms length transaction between a willing and informed buyer and seller with no hidden or liabilities, in a balanced market. A balanced market is one where supply and demand are reasonably equal, and where neither is affected by short-term events. Short-term events generally include events that temporarily alter values such as, for example, extraordinary manufacturer price discounts, fuel costs, war or recessions.

Base value then is a hypothetical value, as the real market is never completely balanced or unaffected by short-term events, and it is generally used to analyze historical values or to project future values. Importantly, base value assumes an aircraft's maintenance status is at half-life, or benefitting from an above-average maintenance status if it is new or fairly new.

7.2 Current Market Value - represents the appraiser's opinion of the most likely trading price that may be generated for an asset under the market conditions that are perceived to exist at the time in question. Market values are often value opinions based on each appraiser's careful analysis of information about recent transactions.

Current market values also considers the perceived demand for the type, its availability on the market, and further takes account of the expressed views of informed industry sources. Similar to base value, current market value assumes an aircraft's maintenance status is at half-life, or benefitting from an above-average maintenance status if it is new or fairly new.

The current market value of an aircraft will tend to be consistent with its base value in a stable market environment. In situations where a reasonable equilibrium between supply and demand does not exist a divergence between base value and market value indicates the existence of some form of imbalance in the market. For example, if the current market value is in excess of base value, this would indicate that prevailing market conditions are tending to support higher trading prices for the aircraft in question.

7.3 Adjusted Market Value - indicates that the market or base value of the aircraft has been adjusted from half-life condition to account for the actual maintenance status. The maintenance you perform on an aircraft has an impact on its value. Therefore, it is important to quantify in monetary terms the maintenance status of aircraft involved in transactions, since a strong relationship exists between the cost of conducting maintenance and value enhancement.

Figure 9 below illustrates the desktop adjusted market values for a 2006 vintage A320-200 aircraft using the half-time adjustment value computed in Example 2 above - the method simply subtracts the adjustment from both the half-life base and current market values.

FIGURE 9 –EXAMPLE: A320-200 MAINTENANCE ADJUSTED VALUATIONS

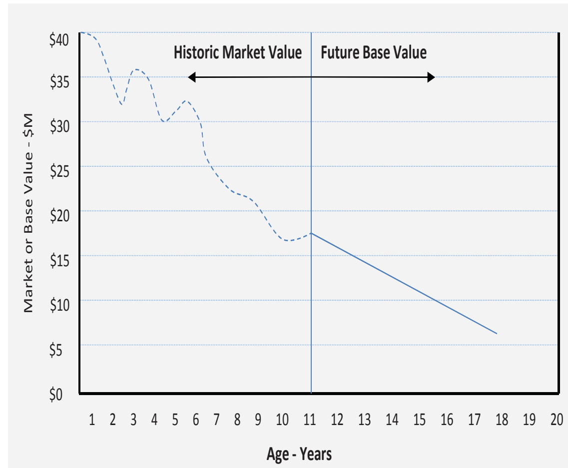
Market Value Source: Collateral Verifications

MAINTENANCE ADJUSTED MARKET VALUES						
Aircraft Model	Build Year	MTOW (lbs)	Market Values	Half-Life Values	Half-Life Adjustment	**Adjusted Values**
A320-200	2006	170,000	Base Value	33,670,000	(1,090,078)	**32,579,922**
			Current Value	27,780,000	(1,090,078)	**26,689,922**

7.4 Future Base Value - is the appraiser's forecast of future aircraft value(s) from an initial starting point that is generally its base value - a curve is generated using normalized data points derived from a base value, and an extension of that curve produces the future base value curve for an aircraft type. Future values are normally projected in current dollars and, as such, future values projections entail inflation assumptions. Appraisers often forecast future values assuming an inflation rate ranging from 2% to 3%.

The future value forecast is also based on the premise that the aircraft will be in half-life condition. Theoretically, the future base value curve should be less volatile than current market values; responding slowly to cumulative changes in current market values that should cycle above and below the future base value curve– Figure 10.

FIGURE 10-HISTORIC MARKET VS. FUTURE BASE VALUES



7.5 Distressed Value – is the value at which an aircraft could be sold under abnormal conditions – typically an artificially limited marketing time period. The perception is of the seller being under duress to sell due factors that materially reduce the bargaining leverage of the seller and give prospective buyers a significant advantage that can translate into heavily discounted actual trading prices.

7.6 Salvage Value – is defined as the actual or estimated selling price of an aircraft, engine or major assembly based on the value of marketable parts and components that could be salvaged for re-use on other aircraft or engines. The value should be determined and stated in such a way to make clear whether it includes adjustment for removal costs.

Salvage Value (Parting-out Value) becomes applicable when disassembly for parts would most probably result in the highest cash yield for the asset "as-is" as compared to the Market Value of the asset as a whole. For high-value items such as engines and landing gear, the salvage value might be estimated on the basis of the remaining "green time" before the item would require a major inspection or overhaul. While such disassembly for parts may result in the highest cash yield that can be generated in the marketplace, an owner may elect to reinvest in the asset to restore it as a working aircraft, engine or major assembly because the asset has a "value-in-use" to him that exceeds the Salvage Value or Parts Value.

Aircraft Appraisal Perspective

The role of the appraiser has expanded greatly over time. Appraisers are called on to assess an aircraft as a flying piece of machinery and as an economic, capital asset entity. As a capital asset, the quantification of an aircraft's value is an analytical process.

All analytical tools rely heavily on interpreting facts and relationships, requiring a great deal of experience and judgment of the part of the appraiser. Though the analysis can never be divorced from the judgment of an experienced appraiser, the appraisal process is less art than many assume.

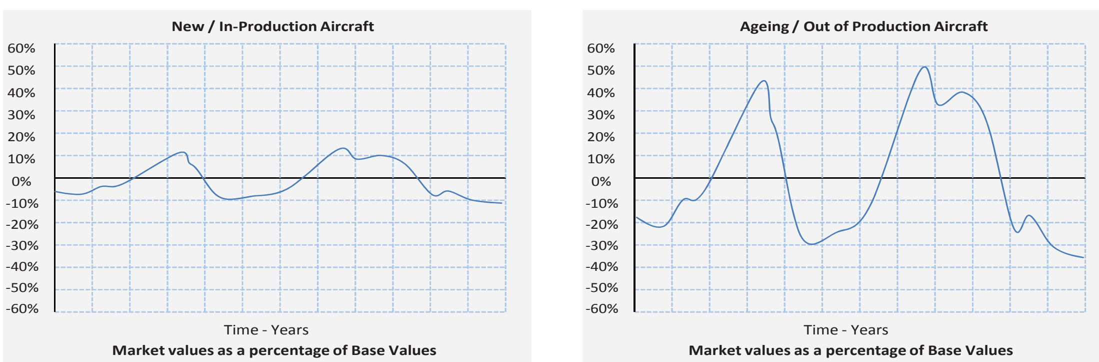
8.0 RELATIONSHIP BEWTEEN AGE AND VALUE PERFORMANCE

An aircraft, like most physical assets, exhibits a depreciation profile whereby its current market value depreciates to a residual value over time. This trend, along with growing obsolescence resulting from new technologies and improvements in fuel burn, contributes to the depreciation process and limits an aircraft's economic useful life. And, as previously discussed, the influence of age is expected to result in higher proportional maintenance costs. Accordingly, most appraisers and traders assume a strong relationship exists between age and market values, and between age and the increased cost of conducting maintenance.

8.1 Aircraft Values Over Time – Aging aircraft have a more elastic response to the economic cycle than newer technology aircraft. Older aircraft in need of major cash expenditures for pending major maintenance events are not likely to remain in service, instead they will be relegated to part-out or permanent retirement. The rational for this is that; a.) Operators and owners no longer have the cash outlays to expend on maintenance and, b.) Any significant expenditure for maintenance is not expected to augment the market value of the aircraft.

In contrast to aging aircraft, newer/younger aircraft are traded less frequently, and therefore there tends to be greater uncertainty about their market values. For an aircraft type just entering commercial service, the historical sales performance of aircraft from the same generic class having widespread commercial acceptance, can provide reasonable indication as to its likely market value. Figure 11 below illustrates the variability in market values between new and aging aircraft.

FIGURE 11 –AIRCRAFT CURRENT MARKET VALUE CYCLE VARIATIONS AS A PERCENTAGE OF BASE VALUES

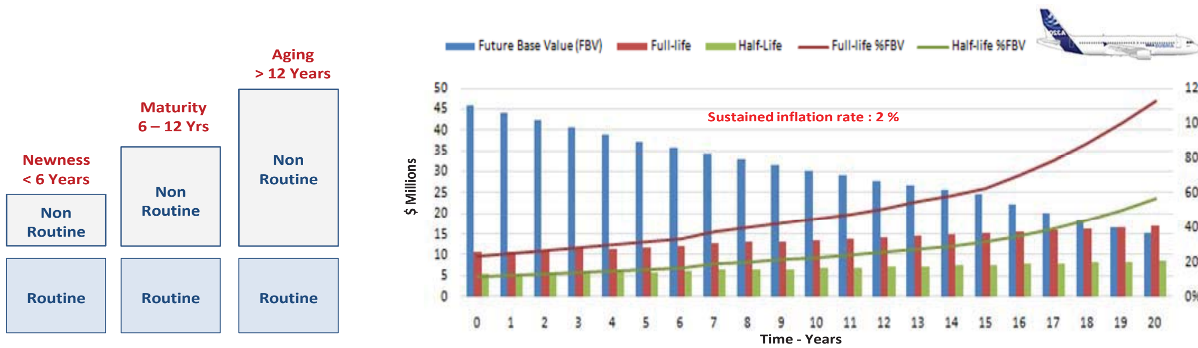


8.2 Maintenance Status Over Time – Generally, an appraiser attempts to attach a value resulting from differences in maintenance status between the hypothetical average aircraft and the aircraft he/she is appraising. For new, or nearly new aircraft, where the maintenance status is half-life or better, the maintenance value adjustment tends be negligible.

As an aircraft ages, maintenance begins to account for a higher proportion of the aircraft's total value; over time, escalating non-routine maintenance tasks require incremental labor to address unscheduled repairs of discrepancies, or to remove and restore defective components. Additionally, higher material costs are expected to be incurred given that costly components begin to reach a state of beyond economic repair, and many piece-parts are scrapped and replaced – see Figure 12.

After an aircraft reaches a certain age the main differentiator between specific aircraft of the same vintage will often be the value in their maintenance status. Thus the position in the maintenance cycle is a source of value difference between aircraft of the same type and vintage, and consequently it is useful to quantify in monetary terms the value of maintenance status.

Figure 12 – Influence of Age on Aircraft Maintenance Valuation



Future Base Values Source: Collateral Verifications

8.2.1 Engine Status Over Time – Of all the major maintenance events accounted for in the valuation of an aircraft's maintenance status, engines in particular, tend to retain their value more strongly as an aircraft ages. An engine's maintenance value is a function of the cost of an engine's Life-Limited Parts (LLPs) and the cost of an engine performance restoration. Given the ability to restore value and useful life through maintenance processes, the economic value of an engine remains relatively firm throughout much of its economic useful life. These factors play a vital role in the behavior of engine maintenance values because, whereas an airframe gradually deteriorates over time as flight hours and cycles accumulate, appropriate levels of maintenance can repetitively restore an engine to a near new condition and value.

Since the value of an engine in the later stages of its economic life is strongly related to the operational green-time remaining, the maintenance status of engines has a growing impact on value. During the final phase of its economic life, when the serviceable engine is operated to the point where an engine shop visit is required, the engine owner must make a decision to either invest in an engine shop visit or disassemble the engine and sell the parts.

Another consideration regards an operator's financial status, which often dictates their policies towards investments in engine shop visit maintenance. Cash constrained operators may view the cost associated with an optimized workscope as being cost prohibited, and instead will opt to minimize their liabilities by scaling down the engine's build standard, which translates into a lower maintenance value.

> ### *Engine Economic Life Perspective*
>
> The economic life cycle of an engine can be divided into three phases.
>
> **Phase 1** starts at the introduction of the engine into regular and finishes when the production run of the aircraft it supports ceases. During this phase: a.) Engine demand grows and values tend to correlate to list prices; b.) The majority of engines have yet to occasion their first performance restoration; c.) New engine warranties still apply; and d.) Few engines are actively traded.
>
> **Phase 2** coincides with the termination of an aircraft's production. During this phase: a.) Engine values are generally stable; b.) Most of the engines are in their mature phase; c.) Stable rate of performance restorations; d.) Engine maintenance status becomes increasingly important.
>
> **Phase 3** represents the period of time following the withdrawal from service of aircraft types that engine's support. During this phase: a.) Demand for engines is much weaker and values start to approach the cost of overhaul; b.) Supply increases as aircraft are retired from service; c.) Remaining engines in the fleet are traded on the basis of maintenance "green time" or part-out.

9.0 RELATIONSHIP BETWEEN MARKET CONDITIONS AND VALUE PERFORMANCE

In the definition of Current Market Value (CMV), market conditions are assumed to be the unknown variable. Theoretically, in a balanced market, an aircraft sold in half-life condition assumes that no profit or loss results from maintenance status. In reality aircraft values, including maintenance residual values, swing dramatically depending on supply and demand.

In periods of strong aircraft demand, the proportion of dollar cost premium attributed to above half-life status will range higher, whereas in a weak market the value will be minimal to zero dollars. The same principal holds true when an aircraft's maintenance status is below half-life, although proportionally the discounts will tend to be higher during weak market conditions, and lower during strong market conditions. Figure 13 below illustrates the likely range of maintenance status adjustments that could be achieved under the market conditions existing at the point of sale (i.e. weak, balanced & strong).

FIGURE 13- LIKELY RANGE OF HALF-LIFE ADJUSTMENTS BASED ON MARKET CONDITIONS

Market Status	Maintenance Status	Half-Life Adjustment
Weak	Above Half-Life	Likelihood of no premium for higher levels of maintenance status
	Below Half-Life	Likelihood of significant discount for lower levels of maintenance status
Balanced	Above Half-Life	Likelihood of a premium but not full dollar-for-dollar
	Below Half-Life	Likelihood of a discount as high as full dollar-for-dollar
Strong	Above Half-Life	Likelihood of a premium but not full dollar-for-dollar
	Below Half-Life	Likelihood of minimal discount for lower levels of maintenance status

Figure 14 illustrates the range of potential maintenance adjusted market values for a 2006 build A320 aircraft taking into consideration strong, balanced, and weak market conditions. For ease of explanation the market values is assumed to be unaffected by market conditions. In realty though, aircraft market values are heavily influenced by recessions or sustained periods of economic stagnation. Historically such events have depressed commercial aircraft values by varying degrees of magnitude.

FIGURE 14- EXAMPLE: LIKELY MARKET VALUATIONS ASSUMING STRONG, BALANCED & WEAK MARKET CONDITIONS

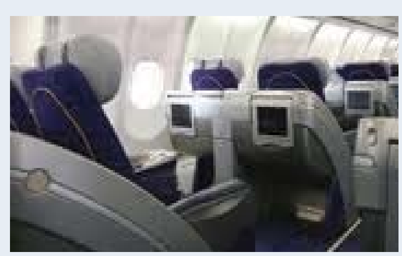
Example : Mtx Adjusted Appraisal based on Market Conditions			Potential Market Adjusted Values		
2006 Build A320-200 	Market Value $	Mtx Half-life Adjust $	Strong Market	Balanced Market	Weak Market
	27,780,000	(2,000,000)	Below $27.00M	$25.00M $26.00M	Below $25.00M
		2,000,000	Below $29.00M	$27.00M $28.00M	Below $27.00M

Market Value Source: Collateral Verification

Aircraft Configuration & Value Perspective

Configuration differences between aircraft of the same type may, in certain circumstances, lead to value adjustments. Configuration improvements such as operating weight increases, winglets, higher thrust engines, and the installation auxiliary fuel tanks will increase value.

But modifications which are airline-specific such as certain In-Flight Entertainments (IFE) systems and unique cabin seats will generally not warrant an increase in aircraft value.



10.0 MAINTENANCE VALUE RECOGNITION IN LEASE TRANSACTIONS

The nature of operating leases requires that the lessee/operator pay the lessor/owner for maintenance utility. The issue of whether an operator pays for maintenance utility is one of security; operators with good credits often do not pay for maintenance utility, or if required, do so at the end of the lease term, whereas operators with weak credit are required to pay for maintenance utility during the course of the lease term. There are two principal ways that lessees pay lessors for maintenance utility:

- Cash Maintenance Reserve Payments. These are usually payments made on a regular, usually monthly, basis by the lessee to the lessor and are generally based upon the age, and utilization of the asset. Accumulated reserves are reimbursed (subject to limitations) after each major maintenance event is completed.
- End of Lease Financial Adjustment. This option would expose a lessor to a greater risk of incurring maintenance costs and is thus usually only offered to better quality credits or airlines that have demonstrated a good track record of payment. There are two types of end-of-lease payment structures:
    - Mirror-In / Mirror-Out – A mirror adjustment can either be one-way, where the Lessee is required to pay an adjustment when a maintenance event is returned with less time remaining than at delivery, or a two-way mirror whereby lessor may have to pay the lessee for each event returned in better condition than at delivery.
    - Zero-Time – A payment whereby the lessor receives payment for time used since last overhaul or since new.

Ideally the reserve fund plus the condition of the aircraft should equal full life, and can be arithmetically expressed as follows:

Net Reserve + Residual Condition = Full-life Condition

When calculating the overall economics of a lease transaction lessors often account the benefit gained from the recognition of maintenance reserves as a source of incremental profit. The timing of this recognition depends on the accounting policies each lessor follows.

During the lease term, lessors will traditionally manage their maintenance reserves as a cost-covering exercise, used primarily for the benefit and integrity of the aircraft. In circumstance where an aircraft is sold with a lease attached then normally the balance of the reserve fund transfers to the new owner. However, if an aircraft is sold at the end of the lease term the lessor can benefit financially by sweeping the balance of reserves.

When assessing the economics of a lease transaction, the lessor often accounts for the residual value proceed from the sale of the aircraft at lease expiry. The future residual value assumes an aircraft's maintenance status is at half-life, and if maintenance reserves are collected then theoretically the proceeds from reserves plus the maintenance residual condition should amount to a value approximately equivalent to full-life. Therefore, the use of maintenance reserves at the end of a lease can potentially offer considerable financial benefits to the owner/lessor, but can also serve to distort the true residual value of an aircraft.

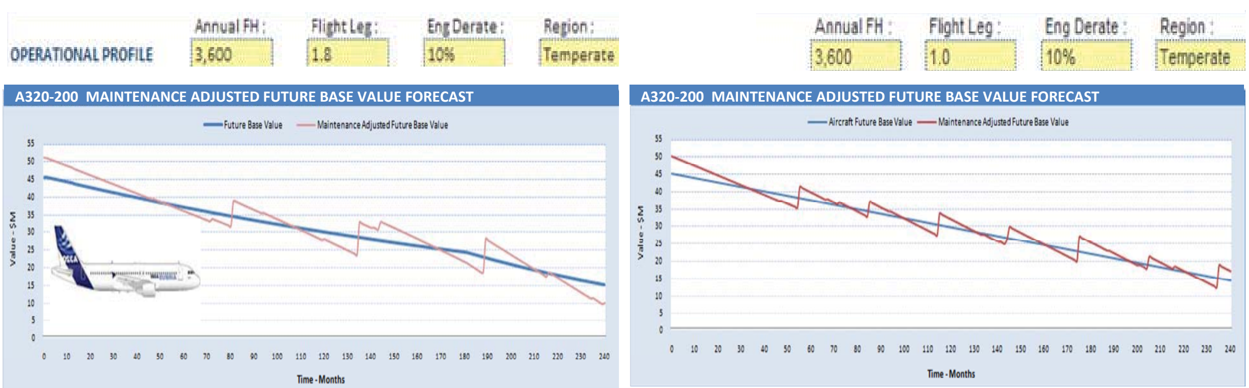
11.0 FORECASTING VALUE CYCLES

One of the primary considerations of any forecast is to attempt to predict future outcomes by taking into consideration both quantitative and qualitative experience drawn from past events. In the case of aircraft future base values, the aim is to predict the value which the aircraft should achieve with reference to the normal depreciation of the underlying asset. It's worth reminding the reader that future base values assume the aircraft will be in half-life condition, and the "base scenario" assumes markets are in equilibrium.

In forecasting an aircraft's half-life maintenance forecast one must take into consideration the operational profile, age, and influence of inflation. Combining an aircraft's FBV plot/curve and its half-life maintenance cycle forecast into a single forecast enables one to define the maintenance adjusted Future Base Value (FBV) forecast - this is undertaken by adding/subtracting an aircraft's projected half-life maintenance status to its FBV plot/curve.

Figure 15 illustrates the maintenance adjusted Future Base Values forecast for an A320 aircraft taking into consideration two different operational profiles; one assuming a flight segment of 1.8, and the other a 1.0 flight segment. For aircraft of the same vintage and specification, one can reasonable infer that the frequency during which its maintenance status occasions half-life becomes greater the more severe its operational profile is, all else equal.

Figure 15-Example Maintenance Adjusted Future Base Value Forecast for Different Operating Profiles



What influences this trend the greatest is the effect more severe operating profiles has on the time on-wing characteristics of engines - the harsher the operational profile the greater the rate of performance deterioration on engine modules and LLPs and the less time an engine remains on-wing. Therefore, relative to other maintenance events, engine maintenance status should to be carefully monitored given the greater influence it imparts on residual values of aircraft.

Engine Maintenance Value Perspective

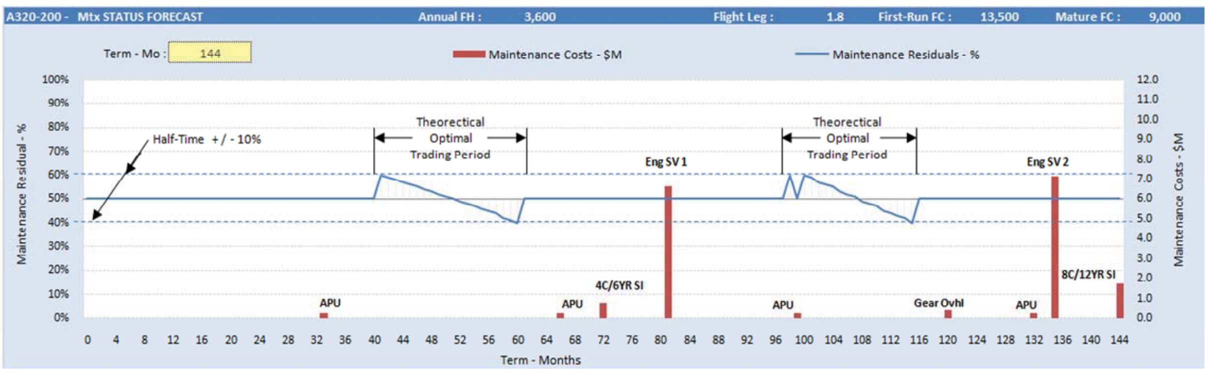
Young and popular engines can be relied upon to regain their original market value when they have maintenance. However, Investors should be wary of an engine entering into a phase of market decline when it starts to decrease in popularity. When the numbers of an aircraft type in operation starts to diminish, the fleet of engines supporting that aircraft fleet increases. The effect is an increasing ratio of spares to installed engines, which weakens their market value.

12.0 FRAMING THE OPTIMAL TRADING PERIOD

The recapture of dollar-for-dollar expenditures for maintenance status is rarely achieved, therefore aircraft sellers should account for an optimal trading period that considers the timing of major maintenance events. Alternatively, a buyer more than likely will discount the value of maintenance status below half-life on a dollar-for-dollar basis if the conditions of the sale are distressed or if the market conditions are weak. More importantly, framing when to trade an aircraft from a maintenance status perspective should take into consideration the age of the aircraft (i.e. new, mature, or aging).

12.1 New-to-Mature – To mitigate a penalty for status below half-life, or to maximize the recapture of capital investment in major maintenance events, traders should consider targeting the transaction during a phase where overall maintenance residual value is within a threshold of half-life. For new-to-mature aircraft, a general rule is to target trading periods coinciding with an engine's mid-life status – Figure 16.

Figure 16- Theoretical Optimal Trading Forecast For New to Mid-Life Aircraft



12.2 Mature-to-Aging – Once the aircraft enters the mature-to-aging phase its maintenance status takes on considerably more relevance. The effects of age results in higher airframe-related non-routine maintenance costs, and the associated engine type will likely begin to incur more frequent, and often more expensive shop visit costs. At some point during this phase the owner of the asset will be forced to make a decision to either continue operating the aircraft (incurring subsequent higher maintenance costs), or to sell the aircraft for its part-out value.

The value of an aircraft at this stage will be concentrated primarily through its engines, or more concisely, through the maintenance status of its engines. Serviceable engines with lots of green time remaining will have considerable more economic value than engines with timed-out modules and LLPs. Consequently, the optimal trading period during this phase of an aircraft's life cycle will be primarily driven by the overall condition of its engines.

12.2.1 A Caveat to Age and Value Cycle – Although most valuation analysis will likely find aging aircraft to be economically unfeasible, it's important to distinguish between efficiency and the cost of necessary levels of efficiency. Modern aircraft will traditionally incur lower direct operating costs, and in particular maintenance costs, but require higher ownership costs (depreciation & financing). Through lower capital costs, aging aircraft can achieve a relative economic advantage despite having higher operating costs. Therefore, the principal to keep in mind is that the choice of an aircraft is predicated upon the requirements of its mission and the resulting economics of that mission. It's the specificity of the mission, the definition within context, which gives rise to value.

CONCLUSIONS

A key risk exposure to aircraft investment is asset risk, with the value of the aircraft at sale being a critical component of overall return on investment. The investment return will often be influenced by the aircraft's maintenance status, and therefore trading in commercial aircraft suggests ongoing monitoring and forecasting of an aircraft's maintenance status. The analysis of the relationship between an aircraft's value and its maintenance status reveals the following trends:

- The value of maintenance status is rarely constant; the volatility of markets inherently translates into volatility of aircraft market values, and by correlation, volatility in its maintenance status valuation. In capacity shortage conditions planes are kept flying and the issue of maintenance status takes on lesser significance. In a capacity surplus situation, aircraft which have poor maintenance status are often scrapped.
- Obtaining dollar-for-dollar premium for maintenance status is rarely achieved. To minimize the potential for losses associated with maintenance investments, aircraft traders should account for an optimal trading period that considers the age of the aircraft as well as the timing of major maintenance events.
- In forecasting the future value of maintenance, the operational profile, airframe age, and inflation rate should be considered as an integral part of the methodologies used to assess the value of maintenance.
- After an aircraft reaches a certain age the main differentiator between specific aircraft of the same vintage will often be the value in their maintenance status. Thus the position in the maintenance cycle is a source of value difference between aircraft of the same type and vintage, and consequently it is useful to quantify in monetary terms the value of maintenance status.
- Although the life cycle of an aircraft engine is closely connected to that of the aircraft type (or types) it supports, the experience of engine values over time bears little resemblance to that of an aircraft. Whereas an airframe gradually deteriorates over time as flight hours and cycles accumulate, appropriate maintenance can repetitively restore an engine to a near new condition and value. Therefore, engine maintenance status needs to be carefully monitored given its influence on aircraft market values.

MSG-3 and Airframe Valuation Perspective

For modern aircraft types (e.g. B737NG family and B777), the "letter check" distinctions are often less important, since MSG-3 task-orientated maintenance programs are employed. Maintenance programs developed with MSG-3 have all tasks assigned with varying intervals (i.e. flight hours, flight cycles, and calendar time). Many of the tasks combine two of these intervals. This process allows operators to group maintenance tasks into packages to form maintenance checks in the manner that is most efficient for them, rather than having tasks grouped into checks that are predefined by the Maintenance Planning Document (MPD). This process permits maximum utilization of task intervals.

However, appraisers must give special treatment to aircraft under MSG-3. The traditional aircraft appraisal method of relying on the "D" checks to "zero-time" the airframe is made considerable more difficult under MSG-3. One can argue that the residual value of an aircraft maintained under MSG-3 should be higher, because the overall condition of an MSG-3 maintained aircraft should be theoretically greater than one that is "run out".

APPENDIX 1 – FACTORS INFLUENCING AIRCRAFT VALUES

Appraisers weigh in a number of factors when valuing an aircraft, and key among them is the aircraft type, model, and age, and whether the asset is in good condition, with no damage history and all Airworthiness Directives (ADs) and significant Service Bulletins (SBs) complied with. They also assume it has a full and complete set of technical records and documentation. The key determinants that influence an aircraft's market value can be categorized by: 1.) Manufacturer determinants, 2.) Aircraft determinants, and 3.) Market determinants.

1. Manufacturer Determinants

a. Pricing strategy. If OEM deep discounts persist the residual values in turn will not return to their historical levels relative to appraised base values.

b. Manufacturer demise. The demise of either the airframe or engine manufacturer will often significantly impair residual values.

c. Production runs. Long production runs tend to enhance aircraft residual values.

d. Production cycle. Early and final phase production units tend to have lower residual values.

2. Aircraft Determinants

a. Aircraft age. Residual values become less stable as an aircraft ages.

b. Aircraft specifications. Gross weight configuration, engine configuration, flight-deck configuration. In general, generic is good, uniqueness is bad. Multiple variants divide the fleet into small sub-fleets and consequent markets.

c. Aircraft operating history. The aircraft under consideration is used in typical operations with an average utilization and sector length as might be expected for the class of aircraft.

d. Aircraft family and technology. Aircraft families are the most attractive – they provide fleet and capacity planning flexibility. Modern technology, particularly engine technology improves secondary market prospects since it lowers operating costs and prolongs useful life.

e. Aircraft operating economics. Payload characteristics (seat & cargo capacity), range capability, and speed characteristics. Generally speaking, comparison of ownership cost per operating cost per block-hour. The key economic expense drivers of an aircraft are: maintenance, fuel, and ownership costs. On a comparative basis, similar-sized older and younger aircraft will have the same crew-related and ownership costs, so fuel and maintenance will be the main cost elements (operating) that influence total costs.

f. Aircraft secondary market prospects. Conversion to freighter is the largest secondary market. The supply of aircraft for freighter conversion always exceeds the requirements. Another market is parting-out for rotables, engines, and other components. The aircraft with the best chance of realizing good residual values are those that are relatively young and sell into the secondary market early.

3. Market Determinants

a. Market conditions. Strong, normal/balanced, weak. Actual residual values will be closer to base values in normal market conditions.

b. Market Liquidity. Appraisers will look at the number of planes in service and on order, the number of operators, and the breadth of the manufacturer's product line, among other factors. Narrowbody aircraft are typically considered to be slightly more liquid, other things being equal, than widebody aircraft.

c. Airline profits margins. There is strong correlation between airline profits and aircraft values. In general, as profits increase so do aircraft values. When traffic volumes are high, planes are filled and they operate at high utilization. When traffic volume is down, over capacity develops in the market – ticket prices go down in an effort to fill the planes, and surplus aircraft are retired or sold off.

d. Airline traffic growth. A good measure for demand for aircraft is air traffic growth, which can be expressed in the growth of Revenue Passenger Miles (RPM) flown per year.

APPENDIX 2 – BUREAU OF LABOR STATISTICS DATA RETRIEVAL INSTRUCTIONS

1. Go to the BLS web site at: http://data.bls.gov/cgi-bin/srgate
2. You will then be prompted to enter the series ids for the data you wish to retrieve. You may select one or more series id's at a time. Below is a description of each series id.
    a. **ciu2023211000000i** - NAICS Wages & Salaries Aircraft Manufacturing
    b. **wpu03thru15** - PPI - Industrial Commodities Index
3. Type in the Series id, select the years you wish to view & click to retrieve data.

APPENDIX 3 – EXAMPLE: HALF-LIFE MAINTENANCE FORECAST

A320-200 - CFM56-5B4/P 27,000 lbs - Mtx STATUS FORECAST							Annual FH :	3,600	Flight Leg :	1.80		
	Full-life	Mtx Consumed		------------ Maintenance Value Restored ------------						Mtx Residual		Mtx
Mo	Value $	Monthly $	Net $	4C/6YR SI	8C/12YR SI	Gear	APU	Modules	LLPs	Residual $	Residual %	Half-Time $
0	11,125,000	-	-	-	-	-	-	-	-	11,125,000	100%	5,562,500
1	11,125,000	114,886	114,886	-	-	-	-	-	-	11,010,114	99%	5,447,614
2	11,125,000	114,886	229,772	-	-	-	-	-	-	10,895,228	98%	5,332,728
3	11,125,000	114,886	344,658	-	-	-	-	-	-	10,780,342	97%	5,217,842
4	11,125,000	114,886	459,544	-	-	-	-	-	-	10,665,456	96%	5,102,956
5	11,125,000	114,886	574,431	-	-	-	-	-	-	10,550,569	95%	4,988,069
6	11,125,000	114,886	689,317	-	-	-	-	-	-	10,435,683	94%	4,873,183
7	11,125,000	114,886	804,203	-	-	-	-	-	-	10,320,797	93%	4,758,297
8	11,125,000	114,886	919,089	-	-	-	-	-	-	10,205,911	92%	4,643,411
9	11,125,000	114,886	1,033,975	-	-	-	-	-	-	10,091,025	91%	4,528,525
10	11,125,000	114,886	1,148,861	-	-	-	-	-	-	9,976,139	90%	4,413,639
11	11,125,000	114,886	1,263,747	-	-	-	-	-	-	9,861,253	89%	4,298,753
12	11,125,000	114,886	1,378,633	-	-	-	-	-	-	9,746,367	88%	4,183,867
13	11,125,000	114,886	1,493,519	-	-	-	-	-	-	9,631,481	87%	4,068,981
14	11,125,000	114,886	1,608,406	-	-	-	-	-	-	9,516,594	86%	3,954,094
15	11,125,000	114,886	1,723,292	-	-	-	-	-	-	9,401,708	85%	3,839,208
16	11,125,000	114,886	1,838,178	-	-	-	-	-	-	9,286,822	83%	3,724,322
17	11,125,000	114,886	1,953,064	-	-	-	-	-	-	9,171,936	82%	3,609,436
18	11,125,000	114,886	2,067,950	-	-	-	-	-	-	9,057,050	81%	3,494,550
19	11,125,000	114,886	2,182,836	-	-	-	-	-	-	8,942,164	80%	3,379,664
20	11,125,000	114,886	2,297,722	-	-	-	-	-	-	8,827,278	79%	3,264,778
21	11,125,000	114,886	2,412,608	-	-	-	-	-	-	8,712,392	78%	3,149,892
22	11,125,000	114,886	2,527,494	-	-	-	-	-	-	8,597,506	77%	3,035,006
23	11,125,000	114,886	2,642,381	-	-	-	-	-	-	8,482,619	76%	2,920,119
24	11,125,000	114,886	2,757,267	-	-	-	-	-	-	8,367,733	75%	2,805,233
25	11,125,000	114,886	2,872,153	-	-	-	-	-	-	8,252,847	74%	2,690,347
26	11,125,000	114,886	2,987,039	-	-	-	-	-	-	8,137,961	73%	2,575,461
27	11,125,000	114,886	3,101,925	-	-	-	-	-	-	8,023,075	72%	2,460,575
28	11,125,000	114,886	3,216,811	-	-	-	-	-	-	7,908,189	71%	2,345,689
29	11,125,000	114,886	3,331,697	-	-	-	-	-	-	7,793,303	70%	2,230,803
30	11,125,000	114,886	3,446,583	-	-	-	-	-	-	7,678,417	69%	2,115,917
31	11,125,000	114,886	3,561,469	-	-	-	-	-	-	7,563,531	68%	2,001,031
32	11,125,000	114,886	3,676,356	-	-	-	-	-	-	7,448,644	67%	1,886,144
33	11,125,000	114,886	3,526,242	-	-	-	265,000	-	-	7,598,758	68%	2,036,258
34	11,125,000	114,886	3,641,128	-	-	-	-	-	-	7,483,872	67%	1,921,372
35	11,125,000	114,886	3,756,014	-	-	-	-	-	-	7,368,986	66%	1,806,486
36	11,125,000	114,886	3,870,900	-	-	-	-	-	-	7,254,100	65%	1,691,600
37	11,125,000	114,886	3,985,786	-	-	-	-	-	-	7,139,214	64%	1,576,714
38	11,125,000	114,886	4,100,672	-	-	-	-	-	-	7,024,328	63%	1,461,828
39	11,125,000	114,886	4,215,558	-	-	-	-	-	-	6,909,442	62%	1,346,942
40	11,125,000	114,886	4,330,444	-	-	-	-	-	-	6,794,556	61%	1,232,056
41	11,125,000	114,886	4,445,331	-	-	-	-	-	-	6,679,669	60%	1,117,169
42	11,125,000	114,886	4,560,217	-	-	-	-	-	-	6,564,783	59%	1,002,283
43	11,125,000	114,886	4,675,103	-	-	-	-	-	-	6,449,897	58%	887,397
44	11,125,000	114,886	4,789,989	-	-	-	-	-	-	6,335,011	57%	772,511
45	11,125,000	114,886	4,904,875	-	-	-	-	-	-	6,220,125	56%	657,625
46	11,125,000	114,886	5,019,761	-	-	-	-	-	-	6,105,239	55%	542,739
47	11,125,000	114,886	5,134,647	-	-	-	-	-	-	5,990,353	54%	427,853
48	11,125,000	114,886	5,249,533	-	-	-	-	-	-	5,875,467	53%	312,967
49	11,125,000	114,886	5,364,419	-	-	-	-	-	-	5,760,581	52%	198,081
50	11,125,000	114,886	5,479,306	-	-	-	-	-	-	5,645,694	51%	83,194
51	11,125,000	114,886	5,594,192	-	-	-	-	-	-	5,530,808	50%	(31,692)
52	11,125,000	114,886	5,709,078	-	-	-	-	-	-	5,415,922	49%	(146,578)
53	11,125,000	114,886	5,823,964	-	-	-	-	-	-	5,301,036	48%	(261,464)
54	11,125,000	114,886	5,938,850	-	-	-	-	-	-	5,186,150	47%	(376,350)
55	11,125,000	114,886	6,053,736	-	-	-	-	-	-	5,071,264	46%	(491,236)
56	11,125,000	114,886	6,168,622	-	-	-	-	-	-	4,956,378	45%	(606,122)
57	11,125,000	114,886	6,283,508	-	-	-	-	-	-	4,841,492	44%	(721,008)
58	11,125,000	114,886	6,398,394	-	-	-	-	-	-	4,726,606	42%	(835,894)
59	11,125,000	114,886	6,513,281	-	-	-	-	-	-	4,611,719	41%	(950,781)
60	11,125,000	114,886	6,628,167	-	-	-	-	-	-	4,496,833	40%	(1,065,667)
61	11,125,000	114,886	6,743,053	-	-	-	-	-	-	4,381,947	39%	(1,180,553)
62	11,125,000	114,886	6,857,939	-	-	-	-	-	-	4,267,061	38%	(1,295,439)
63	11,125,000	114,886	6,972,825	-	-	-	-	-	-	4,152,175	37%	(1,410,325)
64	11,125,000	114,886	7,087,711	-	-	-	-	-	-	4,037,289	36%	(1,525,211)
65	11,125,000	114,886	7,202,597	-	-	-	-	-	-	3,922,403	35%	(1,640,097)
66	11,125,000	114,886	7,052,483	-	-	-	265,000	-	-	4,072,517	37%	(1,489,983)
67	11,125,000	114,886	7,167,369	-	-	-	-	-	-	3,957,631	36%	(1,604,869)
68	11,125,000	114,886	7,282,256	-	-	-	-	-	-	3,842,744	35%	(1,719,756)
69	11,125,000	114,886	7,397,142	-	-	-	-	-	-	3,727,858	34%	(1,834,642)
70	11,125,000	114,886	7,512,028	-	-	-	-	-	-	3,612,972	32%	(1,949,528)
71	11,125,000	114,886	7,626,914	-	-	-	-	-	-	3,498,086	31%	(2,064,414)
72	11,125,000	114,886	6,961,800	780,000	-	-	-	-	-	4,163,200	37%	(1,399,300)

A320-200 - CFM56-5B4/P 27,000 lbs - Mtx STATUS FORECAST							Annual FH :	3,600	Flight Leg :	1.80		
	Full-life	Mtx Consumed		------------ Maintenance Value Restored ------------						Mtx Residual		Mtx
Mo	Value $	Monthly $	Net $	4C/6YR SI	8C/12YR SI	Gear	APU	Modules	LLPs	Residual $	Residual %	Half-Time $
73	11,242,000	116,511	7,078,311	-	-	-	-	-	-	4,163,689	37%	(1,457,311)
74	11,242,000	116,511	7,194,822	-	-	-	-	-	-	4,047,178	36%	(1,573,822)
75	11,242,000	116,511	7,311,333	-	-	-	-	-	-	3,930,667	35%	(1,690,333)
76	11,242,000	116,511	7,427,844	-	-	-	-	-	-	3,814,156	34%	(1,806,844)
77	11,242,000	116,511	7,544,356	-	-	-	-	-	-	3,697,644	33%	(1,923,356)
78	11,242,000	116,511	7,660,867	-	-	-	-	-	-	3,581,133	32%	(2,039,867)
79	11,242,000	116,511	7,777,378	-	-	-	-	-	-	3,464,622	31%	(2,156,378)
80	11,242,000	116,511	7,893,889	-	-	-	-	-	-	3,348,111	30%	(2,272,889)
81	11,242,000	116,511	2,068,400	-	-	-	-	4,470,000	2,180,000	9,173,600	82%	3,552,600
82	11,772,000	153,904	2,222,304	-	-	-	-	-	-	9,549,696	81%	3,663,696
83	11,772,000	153,904	2,376,207	-	-	-	-	-	-	9,395,793	80%	3,509,793
84	11,772,000	153,904	2,530,111	-	-	-	-	-	-	9,241,889	79%	3,355,889
85	11,772,000	153,904	2,684,015	-	-	-	-	-	-	9,087,985	77%	3,201,985
86	11,772,000	153,904	2,837,919	-	-	-	-	-	-	8,934,081	76%	3,048,081
87	11,772,000	153,904	2,991,822	-	-	-	-	-	-	8,780,178	75%	2,894,178
88	11,772,000	153,904	3,145,726	-	-	-	-	-	-	8,626,274	73%	2,740,274
89	11,772,000	153,904	3,299,630	-	-	-	-	-	-	8,472,370	72%	2,586,370
90	11,772,000	153,904	3,453,533	-	-	-	-	-	-	8,318,467	71%	2,432,467
91	11,772,000	153,904	3,607,437	-	-	-	-	-	-	8,164,563	69%	2,278,563
92	11,772,000	153,904	3,761,341	-	-	-	-	-	-	8,010,659	68%	2,124,659
93	11,772,000	153,904	3,915,244	-	-	-	-	-	-	7,856,756	67%	1,970,756
94	11,772,000	153,904	4,069,148	-	-	-	-	-	-	7,702,852	65%	1,816,852
95	11,772,000	153,904	4,223,052	-	-	-	-	-	-	7,548,948	64%	1,662,948
96	11,772,000	153,904	4,376,956	-	-	-	-	-	-	7,395,044	63%	1,509,044
97	11,772,000	153,904	4,530,859	-	-	-	-	-	-	7,241,141	62%	1,355,141
98	11,772,000	153,904	4,684,763	-	-	-	-	-	-	7,087,237	60%	1,201,237
99	11,772,000	153,904	4,573,667	-	-	-	265,000	-	-	7,198,333	61%	1,312,333
100	11,772,000	153,904	4,727,570	-	-	-	-	-	-	7,044,430	60%	1,158,430
101	11,772,000	153,904	4,881,474	-	-	-	-	-	-	6,890,526	59%	1,004,526
102	11,772,000	153,904	5,035,378	-	-	-	-	-	-	6,736,622	57%	850,622
103	11,772,000	153,904	5,189,281	-	-	-	-	-	-	6,582,719	56%	696,719
104	11,772,000	153,904	5,343,185	-	-	-	-	-	-	6,428,815	55%	542,815
105	11,772,000	153,904	5,497,089	-	-	-	-	-	-	6,274,911	53%	388,911
106	11,772,000	153,904	5,650,993	-	-	-	-	-	-	6,121,007	52%	235,007
107	11,772,000	153,904	5,804,896	-	-	-	-	-	-	5,967,104	51%	81,104
108	11,772,000	153,904	5,958,800	-	-	-	-	-	-	5,813,200	49%	(72,800)
109	11,772,000	153,904	6,112,704	-	-	-	-	-	-	5,659,296	48%	(226,704)
110	11,772,000	153,904	6,266,607	-	-	-	-	-	-	5,505,393	47%	(380,607)
111	11,772,000	153,904	6,420,511	-	-	-	-	-	-	5,351,489	45%	(534,511)
112	11,772,000	153,904	6,574,415	-	-	-	-	-	-	5,197,585	44%	(688,415)
113	11,772,000	153,904	6,728,319	-	-	-	-	-	-	5,043,681	43%	(842,319)
114	11,772,000	153,904	6,882,222	-	-	-	-	-	-	4,889,778	42%	(996,222)
115	11,772,000	153,904	7,036,126	-	-	-	-	-	-	4,735,874	40%	(1,150,126)
116	11,772,000	153,904	7,190,030	-	-	-	-	-	-	4,581,970	39%	(1,304,030)
117	11,772,000	153,904	7,343,933	-	-	-	-	-	-	4,428,067	38%	(1,457,933)
118	11,772,000	153,904	7,497,837	-	-	-	-	-	-	4,274,163	36%	(1,611,837)
119	11,772,000	153,904	7,651,741	-	-	-	-	-	-	4,120,259	35%	(1,765,741)
120	11,772,000	153,904	7,385,644	-	-	420,000	-	-	-	4,386,356	37%	(1,499,644)
121	11,772,000	153,904	7,539,548	-	-	-	-	-	-	4,232,452	36%	(1,653,548)
122	11,772,000	153,904	7,693,452	-	-	-	-	-	-	4,078,548	35%	(1,807,452)
123	11,772,000	153,904	7,847,356	-	-	-	-	-	-	3,924,644	33%	(1,961,356)
124	11,772,000	153,904	8,001,259	-	-	-	-	-	-	3,770,741	32%	(2,115,259)
125	11,772,000	153,904	8,155,163	-	-	-	-	-	-	3,616,837	31%	(2,269,163)
126	11,772,000	153,904	8,309,067	-	-	-	-	-	-	3,462,933	29%	(2,423,067)
127	11,772,000	153,904	8,462,970	-	-	-	-	-	-	3,309,030	28%	(2,576,970)
128	11,772,000	153,904	8,616,874	-	-	-	-	-	-	3,155,126	27%	(2,730,874)
129	11,772,000	153,904	8,770,778	-	-	-	-	-	-	3,001,222	25%	(2,884,778)
130	11,772,000	153,904	8,924,681	-	-	-	-	-	-	2,847,319	24%	(3,038,681)
131	11,772,000	153,904	9,078,585	-	-	-	-	-	-	2,693,415	23%	(3,192,585)
132	11,772,000	153,904	8,967,489	-	-	-	265,000	-	-	2,804,511	24%	(3,081,489)
133	11,772,000	153,904	9,121,393	-	-	-	-	-	-	2,650,607	23%	(3,235,393)
134	11,772,000	153,904	9,275,296	-	-	-	-	-	-	2,496,704	21%	(3,389,296)
135	11,772,000	153,904	2,629,200	-	-	-	-	5,000,000	2,160,000	9,142,800	78%	3,256,800
136	11,772,000	153,904	2,783,104	-	-	-	-	-	-	8,988,896	76%	3,102,896
137	11,772,000	153,904	2,937,007	-	-	-	-	-	-	8,834,993	75%	2,948,993
138	11,772,000	153,904	3,090,911	-	-	-	-	-	-	8,681,089	74%	2,795,089
139	11,772,000	153,904	3,244,815	-	-	-	-	-	-	8,527,185	72%	2,641,185
140	11,772,000	153,904	3,398,719	-	-	-	-	-	-	8,373,281	71%	2,487,281
141	11,772,000	153,904	3,552,622	-	-	-	-	-	-	8,219,378	70%	2,333,378
142	11,772,000	153,904	3,706,526	-	-	-	-	-	-	8,065,474	69%	2,179,474
143	11,772,000	153,904	3,860,430	-	-	-	-	-	-	7,911,570	67%	2,025,570
144	11,772,000	153,904	2,267,333	897,000	850,000	-	-	-	-	9,504,667	81%	3,618,667

REFERENCES

1. **Leighton, P (The Aircraft Value Analysis Company).** Assessment of Aircraft Values – Current Market Conditions versus Historical Trends, May 2009
2. **Aircraft Value News.** Half to Full Life Maintenance Adjustment Continues to Confuse Values, Vol. XVIII No. 24, Nov, 2009, pp 2-3.
3. **Aircraft Value News.** Older Aircraft Face Junkyard That Much Sooner, Jun, 2009, pp 2-3.
4. **Dailey, C.** Holding Up Nicely*, AirFinance Journal, Sep, 2007*.
5. **Sheridan, M. & Pieniazek.** Residual Values – Forecasting with Confidence*, Aircraft Finance* Annual
6. **Kelly, D (Avitas).** Forecasting Aircraft Values: An Appraiser's Perspective*, AirFinance Annua*l. pp. 24-30
7. **Gallagher, T.** Aircraft Finance and Airline Financial Analysis in the Fifth Cycle of the Jet Age. *The Handbook of Airline Economics*. Section 4, PP 223-234
8. **Hallerstrom**, **N (PK AirFinance)**. (2000). The Aircraft Value Cycle, pp. 8-12.
9. **Airline Fleet & Asset Management.** Allowing for Maintenance Condition, Issue Oct/Sep, 2001, pp 48-55.
10. **Airline Fleet & Asset Management.** Engine Values Over Time, Issue Jul/Aug, 2001, pp 32-39.
11. **Lacey, N. & Stein, A.** Airline Maintenance Programs – A Challenge for the Appraiser / Part 1 – Trends in Airline Maintenance Practices will Require Appraisers to Alter their Methods, 2003
12. **Lacey, N. & Stein, A.** Airline Maintenance Programs – A Challenge for the Appraiser / Part 2 – Maintenance Programs and Aircraft Values, 2003

ACKNOWLEDGEMENTS

- I am deeply indebted to Chris Dailey from Jackson Square Aviation and Colin Bole from ILFC, whose help, insightful suggestions and encouragement assisted me in the research and writing of this project study.

SOURCES OF DATA

- Aircraft values from Collateral Verifications - an aircraft appraisal and aviation consulting firm led by Gueric Dechavanne, an appraiser certified by the International Society of Transport Aircraft Trading (ISTAT).

About the author:

Shannon Ackert is Vice President of Capital Markets at Jackson Square Aviation, a leading lessor of commercial aircraft headquartered in San Francisco, CA. He received his B.S. in Aeronautical Engineering from Embry-Riddle Aeronautical University and MBA from the University of San Francisco. Mr. Ackert started his career in aviation as a flight test engineer for McDonnell Douglas and also worked in senior engineering roles at United Airlines as well as United Technologies. In 2000, Mr. Ackert transitioned to aircraft leasing where has specialized in identifying and quantifying the expected risk and return of aircraft investments, as well as providing technical and market advisory services. Mr. Ackert has published numerous research reports focused on aircraft maintenance economics.