“Where’s the Rest of Me??”: Valuing an Aircraft with Nothing Left but the Logbooks

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The Overview

On November 13, 2013 at 1823 CTS, a Merlin SA-227AC on a five-mile VOR/DME final approach to the Red Lake airport in Ontario, Canada had a turbine blade in the left engine let loose. The aircraft had been stabilized on the instrument approach at the time into reported winds at 320 degrees, visibility eight miles in light snow and a cloud cover at 2,000 feet. The crew did not identify the problem correctly or apply appropriate corrective actions and instead pushed all the power controls forward. The airplane rolled left and dove into the ground killing the crew, though some passengers survived.

The Transportation Safety Board of Canada (TSBC) review of the accident concluded that the cause was divided between (1) the crew’s inappropriate response due to a lack of training; (2) metal fatigue in the turbine blade; and (3) an inappropriately-executed maintenance procedure involving the fuel injectors of the turbine chamber. The accident became the teaching touchstone for presentations on the management of the Garrett engines that were on this aircraft and are used on many other aircraft, including the MU-2.

The issue in this crash was the Negative Torque Sensing (NTS) system that is part of the Garrett engine powertrain. In essence, when sufficient torque is lost, the propeller is “windmilling” (due to air pressure on the blades); if the torque decays to 4% of rated power, the propeller blades will auto-feather. In this case, when the crew commanded full power following the turbine blade failure, the crippled left engine was able to produce more than 4% power and the blades didn’t feather. But that engine could not produce *enough* power to overcome the drag created by the prop, therefore creating sufficient asymmetric to roll the aircraft. For those interested in the full story, please see the TSBC report #A13C0150.

The Assignment

On January 30th, 2018 (a full four-plus years after the crash), I was retained to provide an appraised value for the aircraft one second before the engine failed on November 13, 2013. Almost five years had passed since the crash and this was the final step in settling the lawsuits surrounding the accident. The claim for the airframe by the airline had been paid by the hull insurer. I was engaged to be a part of the team that represented the engine manufacturer to determine their liability for the hull in the crash.

Clearly, there was no wreckage to be examined. All that remained of the aircraft were log books and some "old-timers" who knew this make/model aircraft when it was new. These 'old timers' proved invaluable in providing not only an understanding of the aircraft, its engines, life limits and modifications, but also providing the cost of modifications and repairs that had been made on this particular Merlin.

The Quick Answer

Merlin aircraft have long been out of production. In addition, they were not in heavy use even in 2013. Their two most frequent uses were as freight haulers and short-hop airline passenger and freight transport. When new, the value of these aircraft was about $3.8 million. The values for these aircraft since about 2011 had flatlined at $750,000. Year after year (excluding adjustments for engines, airframe, etc.), the 'average' price of these aircraft was $750,000.

But an appraisal is a Market Valuation of a specific aircraft, not an average value, so more work had to be done. What follows is the effort to go from an average market aircraft to the value of the subject aircraft moments before its untimely demise.

The Engines

The subject aircraft was manufactured in 1991 and had 35,475 hours on the airframe when it crashed. The left engine had 32,267 hours since new and 2,948 hours since overhaul. The right engine had 18,526 hours since new and 3,025 hours since overhaul. The engines were maintained on the Continuous Airworthiness Maintenance (CAM) inspection program that allowed the operator to extend the Time Between Overhauls (TBO) from 5,400 to 7,000 hours.

So – what were the engines worth when running just before the crash? To figure that out, one first needs to know the manufacture dates of the engines. Remember, we are looking at a 2013 event and the appraisal is being done in the 2018-19 time frame. The engines were last overhauled in 2011 and 2012. The price of parts and the cost of labor was different in 2011/12 than it was when the appraisal was being done in 2018/19. Extensive decompilations of the engines were done, turbine blade by turbine blade, to determine the remaining life on the parts that made up the engines.

The reduced number of these engines in service compounded by a lack of spare parts for the engines in 2018 meant that one could not use the overhaul prices in 2018 as representative of the costs in 2013. In fact, the values in 2013 were significantly less. The research effort to find an appraised value for the engines required tracking down folks at both CopperState Aviation and Turbine Standard and then researching what overhauls had cost in 2013 versus 2018. The difference, not surprisingly, is that it cost as much as 50% more for the same overhaul in 2018 versus 2013. With extensive reliance on multi-factored spreadsheets, the market values of the engines were determined at the time of the crash in 2013.

Interior/Exterior Condition

It is challenging to try to discern the condition of the exterior and interior of a burned-out aircraft from the logs. The Interior carpet and seats were redone on 4/28/2011 at 32,470 hours, and 43,810 cycles. At the time of the accident, the airplane had about 35,472 hours and about 48,110 cycles. That means that the cabin had been loaded/unloaded about 4,300 times (48,110-43,810) since the interior was refurbished. This number of cycles or usage level would constitute a significant amount of wear and tear on the interior and make its condition Low Average. The exterior paint was considered even worse, as the last repaint was done in 2007, making the paint six years old at the time of the crash.

The Merlin 227 aircraft is a dual-purpose aircraft that can be configured for either cargo or passenger operations. The logs showed numerous weight and balance calculations that were done for both configurations, which meant the seats for the aircraft were optional and removable. Sixteen seats were the standard configuration of this aircraft when used as a passenger transport. The seats were quoted to the appraiser on 7/6/2018 by Dodson International Aircraft Parts at $2,500 per seat. There were numerous repairs to the seats noted in the logs which including welding and replacing parts. So it is reasonable to consider these seats as used originals, probably dating to 1991. The 16 seats were valued at $40,000 (16*$2,500).

Maintenance

A read-through of the technical logbooks shows an every-other to every-third day list of repairs, fixes or other mechanical issues addressed by maintenance in the ten-plus months of servicing this aircraft prior to the crash. In printed form, the log is 96 pages long and if one projects that there are approximately five to seven items per page, the sum total of maintenance issues addressed in ten months is approximately 576 -- almost two per calendar day. In fairness, some of these items were standard maintenance items; however, many were not. It was clear that this was an ‘old’ aircraft that needed constant passenger cabin maintenance for such things as seats and lights, as well as many repairs to the airframe. Here is a short sampling of the virtually non-stop repairs:

1. 11 feb 2013 RH windshield heat temp controller to be removed to service
2. 26 feb Remove LH wing extension to accommodate for repair of LH wing rib at WS 266.
3. 27-Feb-2013250609 0.0 0: Floor stringers under center cabin floorboards on RH side cracked and stop drilled at FS's 242.271,
4. 254.521, 317.271, 332.271, 347.271, 362.271, 377 and 392.
5. 28-Feb-2013 Right outboard nacelle to wing fairing has a 1" long crack on top of wing halfway back. Crack is stop drilled, requires(sp) repair [Note: Spelling error is per the Log]
6. 1-Mar-2013 Job: 1/4" crack at rivet on the upper RH wing aft stringer near WS115.94

7. 7-Mar-2013 Left side of fuselage just behind the cargo door requires a skin repair due to original repair did not hold.
8. 8-Mar-2013 Cabin door forward and aft frames are starting to crack under the door cable support brackets. Forward
9. kick plate is in poor condition. JC#1021NP.
10. Rect: Cabin door forward, aft, upper and lower outer frames replaced.

While the appraiser is not qualified and made no judgement as to the airworthiness of the aircraft, it would appear that the aircraft required a frequent and significant amount of maintenance. With an airframe of almost 35,000 hours, there is no surprise here.

Modifications

Larger aircraft tend not to have the vast array of modifications that are available for smaller aircraft. However, in this case the M7 company offered a gross weight increase modification which had been applied to the subject aircraft. The gross weight modification has obvious advantages for freight carriage, but had somewhat less usefulness for the passenger application for which this aircraft had been tasked. At the time of the crash, the aircraft had five passengers, which meant more than a dozen seats were (fortunately, in this case) unoccupied. Clearly the aircraft wasn't being used to its full capacity.

The standard gross weight for the subject Merlin was 14,500 lbs; the increased capacity was 16,000 lbs. While the modification included some structural enhancements, the majority of the engineering required was to upgrade the brakes so the aircraft could stop within a reasonable distance. M7 was the facility that accomplished these modifications and the cost in 2020 was $300,000. However, the modification was done in 1991 when the aircraft was new. Starting in 2020 and using a standard devaluation calculator (the cost of money) back to 1991, a $300,000 modification in 2020 would have cost $160,000 in 1991.

Modifications do not retain their full value over time and de-value at a standard rate of 5% per year until they become 60% devalued. At that juncture they remain at the de-valued figure for the duration of the aircraft's life. At 5% it would have taken 12 years for this modification to reach its minimum value, and that would have been the year 2003 (1991->2003 12 years @ 5%). Clearly the modification's value had bottomed and now added only $64,000 to the aircraft's value (40% remaining of $160,000 => $64,000). This particular modification hasn't been applied to this make/model aircraft in years, so it was a bit of research and cooperation from M7 that led to a meaningful result.

Life Limit

Small piston aircraft certified under CAR 3 don't really have a life limit applied to the airframes; newer light aircraft certified under Part 23 do have life limitations. Transport category aircraft such as this Merlin have life limits for four components: the airframe, its engines and propellors, and avionics. In general, when an aircraft meets its end of life, the avionics, while typically not life-limited, are generally outdated and basically worthless. The engines and propellers have their own set of airworthiness criteria and need to be overhauled on whatever standard applies directly to them. The airframe, at end of life, is basically scrap [future airport hangar lawn chairs ~ Ed.]. In essence it's worth the sum of its metal components. In a Merlin, generously, about $30,000.

In small aircraft certified under CAR 3, we don't generally think about life limits on airframes. However, if these limits existed, what would you pay for an aircraft that had one hour until its life expired? How about five, ten or 20 hours? The answer is, very little. By the time you placed the aircraft on line and became proficient in its operation, its would-be life limit would have been reached and the airframe would have become unairworthy.

The standard databases such as Aircraft Blue Book and Vref don't really account for this phenomenon. They 'sort of' assume an aircraft being evaluated is in early or mid-life as they adjust for airframe value. This simply doesn't work as you age past a young aircraft. The subject aircraft had 35,000 hours on the airframe and a life limit of 50,000 hours. Discussions with M7 unearthed their frustration in not being able to extend the life of the aircraft. In fact, there is a significant inspection and strengthening process that must be undertaken to get this model aircraft past 35,000 hours. Once done, the aircraft is good to 50.000 hours.

Vref adjusts airframe values for the subject aircraft at $4/hour. If you extend that rate from 35,000 hours to 50,000 hours, the unflyable aircraft is still worth $569,000. Ridiculous! Accounting for the core values of engines and propellers, the value of the aircraft hull is $319,200. Still ridiculous! So – who would pay $319,200 for a hunk of aluminum which generously might be worth $30,000? Obviously, no one would.

The point is that the loss of airframe value accelerates steeply after half the life of the airframe. Valuing a more than half-life aircraft as this one (35,000/50,000 hours => 70% consumed) cannot be accomplished using a standard and linear hourly decrease in value as is presented by the standard aircraft valuation tables.

For this appraisal a non-linear model was developed to represent the airframe value after mid-life. In essence a curve was developed that fairly reflected the aircraft's value at 25,000 hours and then terminated at 50,000 with a scrap value. While a straight line was considered a possible means of connecting those points, a non-linear curve would better represent the aircraft over the second half of its life.

Conclusion

Evaluating an aircraft after its demise is a challenging undertaking. The passage of time between the demise and the assignment is the first obstacle. Forming a picture of the condition of the aircraft from just the logbook entries is challenging and requires using other indicators than just time.

There are the more straightforward calculations that can be derived to determine the engine and propeller values. However, ascertaining the value of the modifications and the effect of time on the airframe can require some serious thinking outside of the linear box. It's one of the many things that make the appraisal process interesting and informative for the appraisers and their clients.

And what was the appraised value in this case? Sorry, only the client got *that* number.