

Implications for Service Parts Management in the Rapidly Changing Aviation MRO Market

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Abstract

In this paper, we examine how fundamental changes that are taking place in the aviation industry are affecting strategies for managing service parts that are needed to support maintenance and repair operations (MRO). We present observations and recommendations based on the results of an empirical research project initiated by a large European airframe OEM that facilitates the sharing of part consumption data from heavy maintenance checks from different MRO and airline operators. The goal of the information sharing program is to improve the performance of provider systems used to manage parts procurement to support the execution of heavy checks. Our results, which are based on analysis of a sample of these data as well as on several case studies of MRO service providers, indicate that there is the potential to simultaneously reduce service parts inventory investment levels and to improve parts availability by adopting a coordinated, data-driven approach for managing parts throughout the entire MRO service supply chain. The proposed approach is based on new forecasting and decision support concepts that integrate scheduled and unscheduled part consumption and optimize cost-service tradeoffs throughout the extended MRO service supply chain.

Introduction

Competition in the aviation industry today is intense and many carriers are on the verge of bankruptcy as a result of increased fuel and labor costs. With significantly lower costs per *Available Seat Mile*, Low Fare Carriers continue to grow their market share, which currently stands at 25% in United States. Many major carriers have responded by merging with their competitors, e.g., US Air/America West, Air France/KLM and Lufthansa/Swiss. This

consolidation is taking place in an industry that is facing growing demand. Indeed, the world-wide active air transport fleet is projected to expand with a growth rate of 5% from 16,500 today to 24,000 by 2012.

The impact of these developments on the maintenance and repair (MRO) market has been profound. Maintenance is one of the largest operational cost categories (after fuel) and as such provides a major opportunity for reducing costs. A bigger global air transport fleet requires higher maintenance capacity. Demand for support services is boosted by the fact that an unprecedented number of new aircraft deliveries that occurred around the year 2000 are now generating their first heavy maintenance events. The volume of the worldwide MRO market has grown from \$21B in 1995 to \$36B in 2004 (CAGR=6.2%) and is projected to continue to grow at 5.6% per annum through 2014 to \$62B.

Low Fare Carriers with their traditionally lean business model, have avoided the strategy adopted by the major airlines in the past of investing in large maintenance organizations. Most Low Fare Carrier maintenance is outsourced to independent or other airline third party maintenance providers. The sharp competition noted above has forced legacy airlines either to follow this trend by outsourcing their maintenance, or to improve efficiency of their internally operated MRO organization. Those airlines that continue to operate an MRO function are looking to lower their maintenance costs by becoming a third party provider to other airlines. As a result of this trend, the share of outsourced heavy airframe maintenance stands at 45% in the US and 29% in Europe, and is growing.

Restructuring of the MRO service parts supply chain

With increasing competition in aerospace industry, the pressure on the margins of both the independent and third party MROs is also increasing. Most MRO business is carried out in North America and in Europe, despite the high labor rates of these regions. Heavy airframe maintenance, which is especially labor intense, offers an opportunity to reduce costs by off-shoring into lower wage countries such as Eastern Europe and Asia. Lufthansa Technik for example, has set up maintenance facilities for heavy checks in Hungary, China, the Philippines and Malta. Many North American Low Fare Airlines source their heavy checks in Central America. This trend has resulted in a more decentralized and complex worldwide MRO supply chain structure with numerous small maintenance facilities at remote locations whose activities need to be coordinated with regional depots operated by OEMs as well as with logistics facilities operated by other suppliers, competitors and airline customers.

This re-structuring of the MRO supply chain has created new demands on global service parts logistics and maintenance planning systems. For a large maintenance facility, it is efficient to stock parts at a central warehouse located close to the facility. But because of the low consumption probabilities and poor forecasting accuracy of most of the items and the huge

variety of parts, inventory holding costs would explode if all parts were to be stocked on-site at every remote maintenance facility.

Therefore, the smaller MROs tend to keep only a very limited number of parts (mainly consumables and some expendables) in stock at their maintenance warehouses. As a result, most parts are ordered on an expedited basis only after an aircraft to be checked has entered the hangar and inspection of parts and systems scheduled for maintenance has been completed. This “inspect – then order” approach can cause longer aircraft maintenance cycle times and increased costs for expedited orders. Additionally, the shipping costs per order will increase with the remoteness of the maintenance facility. As a result it is possible to see disruption of the repair process due to delays in getting required parts to the repair facility. Pre-emptive (“hard time”) replacements could reduce cycle times by eliminating uncertainty in service parts requirements, but this strategy is only used on a limited basis since it will increase the overall cost of ownership to the airline by reducing the effective life of parts, e.g. parts will be replaced before reaching failure.

As long as MROs can pass on the higher logistics costs of today’s service supply chain structure to their airline customers and/or to their suppliers/OEMs, they have little incentive to reduce the number of expedited orders or to change their service parts management policies. The use of cost-plus contracts typically adopted by airlines and MROs supports such “insular thinking”. As a result we have seen that inventories at the MROs are minimized, but the entire supply chain is inefficient.

Today, MROs are not only experiencing pressure from their customers to lower labor costs, but they also are being asked to reduce the cost of maintaining and distributing parts inventories while maintaining or even reducing check cycle times. This has resulted in a dilemma: as MROs adopt decentralized heavy maintenance in lower wage countries, they create more complicated service parts supply chains and increase the potential for longer aircraft check cycle times.

Aviation MRO case study

Our research on the MRO parts supply chain is based on analysis of pooled consumption data and two detailed case studies of medium sized heavy maintenance operators. The first case is based on an independent MRO facility that is located in the United States and that maintains cost-plus contracts with its customers. The second case describes a maintenance facility operated by an airline for both internal and external customers that is located in a lower wage country and that bills for maintenance checks on a fixed price basis. The following figures reflect the impact of these different business models on service parts management: The *inventory per performed maintenance check* of the on-shore MRO is 48% lower than the one for the off-shored MRO. However, the on-shore MRO orders 140% more *parts per check on an expedited basis* and its *average cycle time per check* is 20% higher (Figure 1).

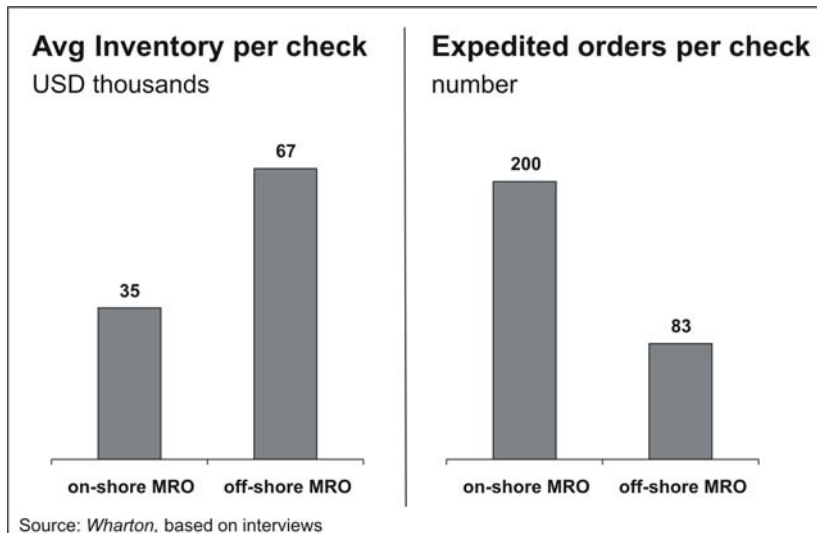


Figure 1: Case study results

Obviously, there is a tradeoff between inventory investment in service parts and the number of expedited orders. The off-shore MRO has decided to maintain higher inventory levels in order to achieve higher off-the-shelf fill rates. This leads to lower logistics (expediting) costs and reduced cycle times. Of course, it is not cost-effective to include all possible parts in the inventory or to increase the overall level of inventory investment across the board. The variety of part numbers that could possibly be used in a major check exceeds tens of thousands and our analysis shows that even in the case of scheduled maintenance, parts consumption is highly random and difficult to forecast. The off-shore MRO has based its inventory stocking decisions on the known maintenance schedule for upcoming check events and historical part consumption data from previous, similar checks. With this information, they set service parts inventory levels based on estimated part consumption probabilities for upcoming checks. While this approach does not eliminate the need for expedited orders entirely, it does allow for the tradeoff between cost and service to be managed directly.

Part consumption data sharing project

A problem that is especially acute for smaller airlines and new MRO operators is that their service part consumption database is not large enough to support the extensive analyses required for the approach described above. As a result, a major European airframe OEM initiated a project to pool heavy check consumption data from its customers (both airlines and MRO operators). This data is collected in a database managed by the OEM and contains observed consumption rates for every part that was used in a check by any customer in the sample during the observation data collection time window (Figure 2). These consumption rates depend on the check type, the aircraft model, aircraft age and operational (usage) history. Estimates of part usage probabilities based on analysis of this database are provided

to the OEM customers to support parts procurement. The accuracy of the usage probabilities based on the shared data is of course much higher than any estimates that an individual MRO could generate on its own.

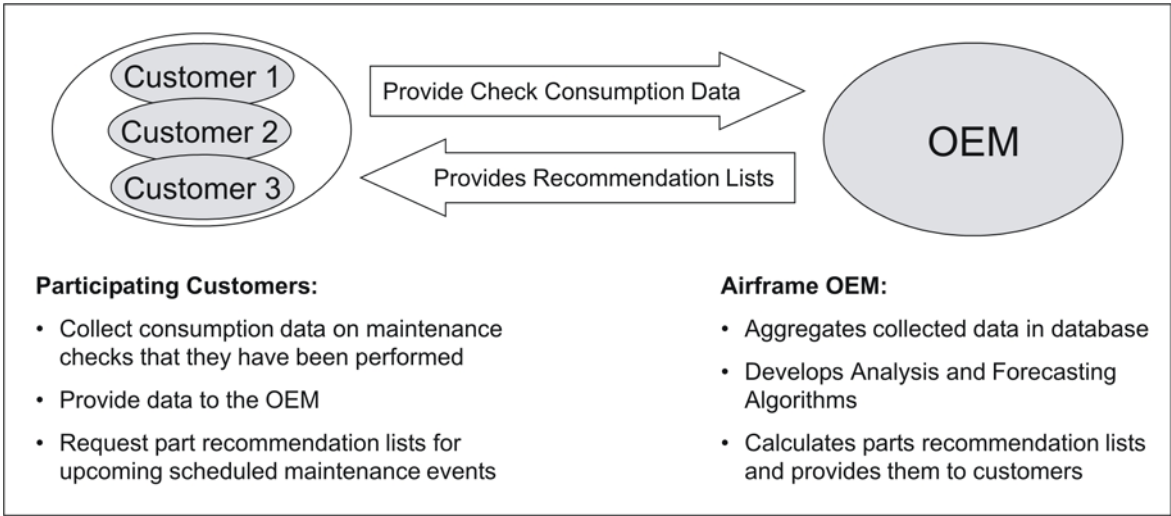


Figure 2: The data sharing process

There is still considerable risk, however, in ordering parts that won't be used and in not ordering parts that are used in any given check. Specifically the airlines and MROs use the estimated consumption probabilities to build service part kits. Based on our analysis of the problem we have proposed an optimal "tool-kit" approach that bases stocking decisions on a cost-usage rate ratio for each part. Parts are ranked in ascending order of the ratio and orders are placed by selecting items from the list in rank order. By picking from the top of this list until a certain budget constraint (or service level – job completion rate constraint) is reached, a list of parts to order is generated. These parts are to be purchased in advance of the scheduled check, before the aircraft enters the hangar. We have used the pooled consumption database to show that the number of expedited orders can be reduced significantly by using this method for ordering parts.

Future prospects for the MRO supply chain

We believe that there is potential to further improve performance of the maintenance check parts supply chain. In particular, the accuracy of consumption probabilities could be increased by linking the parts consumption database to maintenance planning records. As a result the consumption rate of a part could be estimated in a manner that takes into account the timing of maintenance tasks which is based on the known aircraft maintenance schedule, (over some future planning horizon), along with task-specific part utilization rates. Consumption demand forecasts could also be "pooled" across all scheduled maintenance checks that are coincident as well as with predicted unscheduled part failures. Inventory

planning based on the resulting “total” demand picture could then be enhanced by estimating the overall cost and service implications of alternative stocking policies at a maintenance site.

Managers of the service supply chain could derive additional benefits from the data pooling and improved estimation methods described in this paper, by optimizing parts management across the entire MRO parts supply chain that includes the airlines, the OEMs, the suppliers and the MROs. According to an estimate by AeroStrategy Consulting, efforts in the last decade have resulted in a reduction of the inventory held throughout the MRO supply chain, from \$3.6M to \$2.6M per active aircraft. The total value in the supply chain, however, is still \$44B. Thus there is a lot of room for improvement. Given the re-structuring that is occurring throughout the MRO market, we believe that ongoing efforts to reduce inventory investment and to improve service, will require a higher level of supply chain coordination. The goal of the industry should be to achieve joint supplier/OEM/customer management of the parts supply chain. We believe that the insights gained from the data-sharing project described here provide an important first step and that there is potential to build on this effort to improve overall service parts supply chain performance.

A proposed approach to improve the management of service parts logistics

Based on our research and past experience in implementing planning systems in the Aerospace and Defense industries we have developed the following recommendations for optimizing the cost – service tradeoffs associated with managing service parts inventory to support the MRO function.

1. Recognize that predictions of part consumption for scheduled maintenance events is inherently random do the extensive use of inspection and condition based rules for determining parts requirements.
2. Improved part consumption forecasts for scheduled maintenance can be developed by taking into account causal factors such as plane and part age/history as well as the known maintenance schedule of tasks for future checks of each airplane in the fleet.
3. Service parts inventory is positioned at multiple locations that are under control and ownership of various players (airlines, MRO operators, OEMs, independent distributors, etc.). This inventory is utilized to support consumption during scheduled checks and also provides for back-up for unscheduled requirements triggered by failures in the field. These dual uses should be recognized in the methodologies used for generating (probabilistic) part usage forecasts, for making part-location specific investment decisions that determine the advance placement of parts and for determining the advance orders to be made to support consumption for individual scheduled checks.

4. Optimization of these decisions will require a decision support system that captures multi-echelon, multi-indenture interactions and the dynamics of the reverse flows for repairable items. Such decision support systems, moreover, must be tightly linked (in real-time) to the various transaction based and long term planning systems that affect service parts logistics (e.g. the maintenance scheduling system, the procurement and fulfillment systems, the information sharing and pooling systems). See www.mcasolutions.com for a description of a commercial system that utilizes the principles noted here that has been applied successfully in the Aerospace and Defense industry.
5. Incentives have a major impact on how service parts performance is determined, Under the current rules, various players (MROs, airlines, OEMS) often find it in their interest to stock inventory levels that are not those that would be found in a centrally managed, optimally controlled supply chain (e.g. associated with the “first-best” solution). Contracting that includes performance based incentives (based on fleet availability) and appropriate risk and cost sharing mechanisms should be adopted.