AIRCRAFT MAINTENANCE:
SOME STRATEGIES FOR COST CONTAINMENT

Introduction

Today's bottom line-oriented airline managers are searching for innovative solutions to offset operational cost increases and to raise capital for required investments in new technologies, training, and systems. Aircraft maintenance is often considered as a non-core component which adds expenses to the core operations -- providing air service. As airline managers attempt to reduce operating costs, maintenance and associated costs are frequent targets for intensive scrutiny.

Maintenance and overhaul costs generally consist of direct maintenance on the airframe, direct maintenance on the engine, direct maintenance on component parts, and a maintenance burden which can be grouped into related labor cost, material cost and overhead. In general, three different factors influence the maintenance costs of an individual airline. Those factors are: *Airline Policy* (what the airline elects to do), *Aircraft Design* (what the manufacturer can do), and *Airline Situation* (a mix of fixed conditions). All three factors affect maintenance costs but they may vary in degree of importance. Interrelating and influencing each other, these factors affect maintenance and engineering decisions (Stomphorst, Executive Officer Engineering & Sales, ASL , 1995)

General formulas for assessing maintenance expenditures are not easily established because a wide range of costs are incurred by different airlines, owing to the type of aircraft flown, geographic location of operations, and other variables, but we know that historically, airline maintenance accounts for 9% to 16% of airline operating costs. In 1992 alone, United States airlines spent amounts in excess of $9 billion on the maintenance of their fleets. The percentage distribution of costs for labor and materials, outside maintenance, and burden on an average basis is as follows: 32.5%, 30.5%, and 37% respectively. Maintenance costs per available seat mile (ASM) vary throughout the industry and range from 0.38 of a cent for America West Airlines, to 1.35 cents for USAir. For international carriers, the maintenance costs range from a low of 0.6 of a cent to about 3.4 cents per ASM for Swissair (Strahler, March, 1995, X-69).

While studies show that in the past five years airlines have been able to reduce **total** operating costs by as much as 15% per ASM, they have not been equally successful in reducing maintenance expenses accordingly. It is estimated that maintenance costs have been reduced by an average of only 6% to 9%. In fact, four U.S. major airlines actually reported an increase in maintenance costs (Brandt, October 1995, 62).

What are the reasons that carriers have been unable to control these costs? Several reasons appear to explain these results, though they are not mutually exclusive. They are:

(1) excess inventory and related administration;
(2) inability of managements to control rising labor expenses;
(3) aging aircraft fleets;
(4) required work made necessary by regulatory agencies.

Excess Inventory and Related Administration:

Many of the expenditures are incurred due to the massive spare-parts build-up which is estimated to run at $45 billion for the industry. A breakdown of the inventory indicates that about $20 billion accounts for high-value rotables. Non-rotables, both repairables and expendables, account for the remaining $25 billion. An estimated 73% of the total, or $33 billion worth of parts are stocked by jet airlines to support their operations, including more than 4,000 spare engines. The remainder is dedicated to support regional as well as corporate and general aviation (Flint, September 1995, 103). It is estimated that the existing inventory managed by commercial airliners is sufficient to support the entire industry for four years of operations (Flint, September, 1995, 103). However, the most significant cost factor is hidden in the administrative functions of inventory management. Assuming an annual carrying cost of approximately 20%, the aviation industry is spending nearly $8 billion per year to manage and maintain its high-priced inventory. (Angeloni & Michaels, June 1995, 81).

According to safety regulations only 33% of all inventories parts represent items from the Minimum Equipment List (MEL), which are the true "go-no-go" parts. Consequently, operators, who hold nearly 80% of the spares, are not only tying up money in non-performing assets at a time when many are cash constrained, they are wasting funds to maintain large non-performing inventories. (Flint, September 1995, 103).

Inability of Managements to Control Rising Labor Expenses:

Another reason for the inflated maintenance expenditures are the labor costs. A breakdown of U.S. airline data shows that, on a weighted average, 12.20 man-hours of maintenance are spent per aircraft flight hour. Although the cost per man-hour has dropped substantially since deregulation, it is still approximately $45.

After U.S. airline deregulation, maintenance costs as a percentage of operating costs fell to 9%, only to rise again to 11.2% by 1991. Actually, costs per departure has risen continuously over the past few decades. In 1971, maintenance costs per departure were $283.84, but rose to more than $1,250 in 1991, which out paced inflation by about 1% per year. It follows that maintenance as a percentage of operating expenses will continue to increase.

Aging Aircraft Fleet:

Cash outlays for maintenance tasks are projected to increase even further as a result of increasing man-hour requirements. Such a projected increase in man-hours demanded is a direct result of an aging aircraft fleet. It is especially true as companies decide to extend the life cycle of their fleet and defer purchase orders for new aircraft. In the early 90's approximately one-third of the industry fleet was at the critical age of 20+ years.

The percentage of old versus new aircraft will be forced to increase even further. An estimated 2,500 more aircraft are needed to meet traffic demands in the year 2000. So far no more than 700 (28%) new aircraft are currently on firm order from manufacturers worldwide.

Required Work Made Necessary by Regulatory Agencies:

Maintenance organizations carry out specific tasks in order to comply with airworthiness regulations. Those functions and tasks may ensure a higher level of safety but often represent routine work which might not be the most efficient or cost-effective. Illustrative of the effect of the fixed conditions are estimates which suggest that 25% of all

routine work is spent complying with Airworthiness Directives (AD), Service Bulletins (SB), or modifications (MODS) to keep faith with the regulatory environment.

Some Approaches to Cost Containment

Various techniques exist in the management of aircraft maintenance primarily expressed by three main approaches:

(1) in-house;
(2) some combination of in-house and third-party or outsource; and
(3) consortium.

All options can be viable, and each has certain advantages and disadvantages associated with it. The in-house approach is traditional, whereas the advantages of outsourcing have recently emerged. The consortium approach, however, has only been applied in a few instances as airlines seem reluctant to lose control of quality and supervision.

Considerable barriers remain to the rationalizing of airline maintenance. If modern management wants continuous success they need to rethink and redesign their present engineering strategies and associated cost structures. As long as many expenses of aircraft maintenance remain chiefly beyond management control, management needs to take a preventive view of maintenance rather than reacting by simply downsizing and eliminating important layers of control.

IN-HOUSE MAINTENANCE

Since the onset of the aviation industry all carriers conducted independent technical and maintenance operations. Such an approach was operationally and economically feasible given relatively small fleets and a highly-regulated industry with cost containment not of particular importance. As the industry grew there was no need to change this policy since new technology aircraft required fewer intervals between heavy maintenance.

Additionally, airline engineering chiefs were very reluctant to surrender control and supervision outside the company. In-house maintenance was simply regarded as a cost center. High expenses were tolerated because airline managements wanted to be able to adjust to fluctuating flight schedules and make their own operating decisions. The meeting of regulatory-mandated maintenance schedules also made it somewhat impractical for outside involvement. It seemed only natural for airlines to own and operate their in-house maintenance infrastructure and to directly manage rotable inventories.

The control argument certainly has validity since in-house managers can control the operations and forecast future demands, keeping aircraft ground time to a minimum and maximizing revenue flying time. At the same time, extensive in-house engineering suggests a higher level of quality assurance.

However, carriers must weigh the economics and efficiencies of such procedures. Such a concept of a pure cost-center may not be sustainable in a highly competitive environment. The cost of new maintenance facilities can become almost prohibitive if one includes the cost of land acquisition, construction and development, as well as training to enhance technical capabilities. It is becoming clear that major maintenance and overhaul should be performed only by those airlines whose fleet size makes it economically feasible.

According to a recent survey, only 92 or roughly 8%, of 1,200 surveyed airlines have a fleet size which begins to reach a critical-mass level (Shifrin, July 17, 1995, 48). Recent research suggests that in order for in-house activities to make financial sense the fleet should be composed of a minimum of 25 wide-body aircraft. In order to justify independent maintenance engineering infrastructure for small body aircraft, the fleet should consist of at least 40 aircraft (Carrington, September/October, 1994, 15). To rationalize installment of a full engine infrastructure, however, the numbers are even higher. For in-house engine maintenance to be effective, an airline would need a throughput of a minimum of 50 engines per year. With increasing performance of newer generation engines, this volume is far out of reach of most operators. For the remaining 92% of the surveyed airlines, in-house maintenance and overhaul capabilities are probably not economically sound.

Operators are focusing on the total cost of the maintenance function which includes not only direct maintenance expenditures, but also indirect cost such as material and parts procurement, quality control, and engineering (Angeloni, June 1995, 81). As they review the factors, they are seeing that this cost function cannot easily be altered. Perhaps an appropriate time for review is when a new fleet is acquired. Instead of dedicating financial capital to building new maintenance facilities and acquiring the customary support packages of components, tools, equipment, and training, airlines should take a fundamental approach and capitalize on the benefits from shared maintenance (Carrington, September/ October, 1994, 15). British Airways (BA), United Airlines (UAL), and Japan Airlines (JAL) are currently breaking with the tradition of maintaining independent and are trying to set up a global partnership to maintain joint fleets specifically for the Boeing 777.

Of course, for existing airlines that already support small fleets from internal resources, these costs are sunk in the business and it might not make sense to radically change their maintenance programs.

Even though "mega-carriers" have larger scale operations, their particular fleet mix prohibits them from achieving reasonable scale since they do not achieve sufficient levels of commonality. For larger organizations resources can be shared to the fullest extent concerning administrative, distributive, and logistic functions. However, shops, mechanics, and spare parts might only be dedicated to a particular type of aircraft. If there are too many different types of aircraft being operated, each type needs substantial investment in plant and equipment.

When performing in-house maintenance, all resources and technical expertise should be directed towards the type of aircraft and engines which offer greatest compatibility. Continental Airlines, for example, has realized savings of $200 million a year by closing its Denver and Los Angeles facilities and outsourcing large portions of its maintenance after recognizing its diversified fleet and related costs. Yet, Continental has been able to maintain its flight schedules, while redeploying employees and equipment to other locations (McKenna, November 22, 1993, 88).

Other alternatives include a shifting of maintenance functions. After one airline carefully analyzed its maintenance capabilities, it realized that exclusive bases were more efficient in performing distinctive tasks. Accordingly, it developed more specialized and focused bases to which it directed specific jobs.

Unfortunately, such a move does not always lower costs and airline executives need to be careful. The difficulty arises in deciding how to specify a cost. Other non-cost factors also

need to be addressed and are of equal importance (McKenna, November 22, 1993, 88). Direct cost savings might well be attractive. In the long run, however, the company may find itself impaired to perform necessary operations and may suffer from tangible as well as intangible expenditures.

Some of the important questions are:

- Is the cost information pertinent, accurate, timely, and adequate?
- Will the airline avoid a major capital investment in tooling and training or will it waste assets in which it already invested?
- Can people and equipment, freed up when work is contracted out, be redeployed to speed up and reduce the cost of other maintenance activities?
- Will use of outside vendors provide enough savings to offset the cost of terminating workers whose jobs are eliminated by the move?
- Can carriers keep up a free flow of communication and information exchange between the specialized maintenance bases and the airline scheduling group?
- Can carriers maintain the maintenance unit's ability to respond to sudden increases in demand for its services, such as compliance with service bulletins and ADs, if a large portion of the work is handled by a third party?

Some large international carriers are going in the opposite direction and are actually increasing and expanding their maintenance capabilities, turning their cost centers into profit centers. By doing so, they hope to attract third party work which allows for more efficient utilization of their substantial investment (Shifrin, July 17, 1995, 48). This approach represents an internal organizational change and does not mean separating the engineering department. The structure behind this philosophy is meant to make the maintenance activities more task-focused, increasing the overall efficiency of the operation, and supplying the airline with a strong cost control tool for its own maintenance operations (Seidenman, March 1995, X-61).

British Airways has been particularly successful in gaining revenues from outside sources, not only offsetting some of its own costs but additionally contributing to the airline's bottom line. With an expected $218 million in additional revenues from technical operations, the outside revenue is expected to quadruple within just two years (Ott, May 17, 1993, 40). Most major airlines are redesigning their maintenance departments to become more flexible in their operations. Curiously, smaller regional carriers adapt to the opposite method. While major U.S. and European airlines are moving away from comprehensive in-house maintenance, regional carriers are undergoing a transition towards dedicated in-house maintenance. As the acquisition of larger, faster, and more complex turboprop and turbofan aircraft continues, experts foresee the associated maintenance costs to rise as well.

Nonetheless, nowadays only the larger U.S. regionals such as American Eagle, Continental Express, and Piedmont Airlines have the resources and capabilities to handle their own fleet. The regional airlines argue that for every dollar spent for training, systems, procedures, and facilities the return might well be significant (Phillips, July 17, 1995, 47). Cost justification for investing so heavily include savings gained from reductions in rerouting aircraft and ferry flights, and added flexibility provided to the airline.

OUTSOURCING OR THIRD-PARTY MAINTENANCE

Several reasons exist why an airline may choose to contract some, or all of its maintenance needs with an independent facility. An airline may not have a sufficient amount of manpower or the appropriate equipment available to deal with rising fluctuations in maintenance requirements. An individual airline may also recognize that an independent firm offers a substantial advantage in offering specialized expertise in some areas. Moreover, an independent contractor might simply be able to perform the job better and more efficiently than the airline itself (Wells, 1994, 252).

Outsourcing offers greater flexibility in airline operations as lower value activities are contracted out, thus generating savings. A great advantage is realized by cutting down on the maintenance burden, the most unproductive cost item. Additionally, independent contractors often have lower labor costs and thus are able to perform engineering tasks at a lower price. Deregulation spawned the recent trend towards third party maintenance as newer and smaller airlines lacked sufficient funds to set up a complete maintenance infrastructure. At the same time those airlines that effectively outsourced could concentrate more on their primary business which is to provide air services, meeting the demands of the public both in passenger and cargo.

Well-established airlines also found it necessary to go with outside and contract maintenance work. They were unable to cope with both the effects of lower fares brought on by deregulation and economic recessionary conditions.

American Airlines and America West Airlines reflect the highest portions of their maintenance expense in maintenance overhead or burden. They spent $412 million and $37 million per year, respectively, for the burden alone. That translates to 40% and 45% respectively, of their total maintenance expenses (Strahler, June, 1995, 28-29).

In comparison, Southwest Airlines, which has the lowest overall operating costs per ASM, spends only $10 million or approximately 5% of its maintenance budget for overhead. Even though Southwest Airlines operates major maintenance facilities, the carrier contracts out about 90% of its maintenance and this has helped the carrier to establish its cost leadership position.

The cost savings of outsourcing result from the labor intensiveness of maintenance jobs. Even though the cost of materials used makes up a substantial part of the bill, regional wage differences for labor of more than 325% can positively or negatively alter the costs. Intense price competition and overcapacity in the supply maintenance and overhaul industry induced a sharp decline in the per man-hour costs per world region. Data indicates that overcapacity lies between 25% to 30%.

This is a result of some airlines investing in their own maintenance infrastructure to counteract shrinking in-house demand, and to attract third-party work as well as the emergence of new suppliers in formerly underdeveloped areas of the world. Marginal pricing is used to fill these capacities (Stomphorst, Executive Officer Engineering & Sales, ASL). Low costs associated with ferry flights make every geographical locations attractive to potential customers.

Prices should not be the sole determinant of who does the maintenance on the aircraft. Another major issue is the turnaround time and quality of the work performed. Out contracting should not only provide value but also deliver reliable aircraft on-time.

Revenue-generating aircraft not in the air means a loss to the company that cannot be recouped by holding down costs alone. An optimal mix that provides for quality, reliability, cost effectiveness, and technical expertise must be ensured (Seidenman, June, 1995, 25).

To achieve the greatest benefits from third party maintenance, airlines should seek out those providers that are willing and able to support and work towards a cooperative customer-supplier partnership. (Burchell, January/February, 1995, 14). Such a solid affiliation will prevent suppliers from approaching jobs with the intention of maximizing the amount of man-hours from each job. One inclination might be for third party providers to discontinue replacing older parts citing quality issues, with the result of lower parts and lower man-hour charges.

A main issue is to develop better communications between the third party providers and the airlines to increase trust and dependability in their association. Communications and relationships must become very intense for the customer and his representative to become part of the maintenance team. If and when problems arise, information should be shared and dealt with jointly. Work carried out will be more cost-effective and positive feelings will arise (Burchell, January/February, 1995, 14). However, if there is a lack of mutual understanding and respect for one another's needs, negative feelings will emerge and the customer will be consistently on guard.

For the future it is speculated that third party maintenance and overhaul need will continue to increase and offer a valid approach to aircraft maintenance. As the number of seat share of start-up, low point-to-point carriers continues to grow, third party maintenance will be able to offer lower cost alternatives and more efficiency to these new smaller operators. Nonetheless, airlines will need to evaluate critically their cost burden and decide on the best mix of in-house activities and outsourcing.

CONSORTIUMS

One proactive strategy pursued predominantly by large European carriers over the past two decades has been the consortium/partnership approach. It seems obvious that high costs for quality overhaul and maintenance require specialized cooperation for most of the world's airlines. Analysts contend that within the next five years many European and Asian airlines will increasingly pursue maintenance alliances with other carriers in order to achieve competitive and cost efficient operations. Such alliances, according to Phillips, "will feature a pooling of spare parts, technicians, and other resources" to boost productivity (July 17, 1995, 47).

Similar alliances have long been established in Europe, including ATLAS and KSSU. Even though they are in the process of disintegrating due to the decrease of commonality in each of the members' respective fleets, and because of mergers and acquisitions, the concept still offers economic benefits worth discussing. Consortiums have the ability of reducing the high costs associated with operating and maintaining a small fleet of aircraft through a reduction in operating and engineering costs, specifically in the area of overhead. Reducing the overall maintenance burden is achieved by simply spreading the costs over more beneficiaries. Excessive parts and labor costs incurred through duplication are saved as these expenses are spread throughout the engineering infrastructure. Also, separate members can concentrate on developing specific core competencies, resulting in a reduction of the turnaround time (TRT) required to perform a particular function. Aircraft can be put back into service more quickly and parts returned to inventory faster. In the event of a stock-

out, each entity is able to draw from their partner's inventory, therefore, effectively increasing the availability of a single part number at any time.

A phenomena which occurs within larger scale operations is that of the learning curve. Adding new aircraft of a type that is already operational within the alliance will not provoke the same additional break-in costs. On the contrary, the new aircraft will have less impact as it enters the existing fleet. The 20-25% bump in airframe and engine maintenance labor costs usually suffered can therefore be saved (Ruston, Number 14, 9).

In order to reap the maximum benefits, 90% of the critical parts should share a commonality. A common type of aircraft and engines is indispensable for a viable cooperation. Establishing commonality of aircraft types and engines models limits the number of spare parts required and, thus, decreases numbers in inventory holdings and control. As an example, with 47% of all rotable parts, a consortium needs to stock only one item whereas, individual airlines would have to stock one each (Learmount, February 25, 1989, 26-28). Emphasis for standardization, however, should focus mainly on critical components such as engines, avionics, and cockpit configuration, leaving the individual airlines leeway in expressing their individuality in interior and cabin design.

Another advantage associated with cooperative partnerships is an effective reduction in advance purchases of capital intensive investments. According to an Airbus Industry study, the savings for airframe spare investments in value terms can be as much as 90% (Ruston, Number 14, 8).

The following example vividly illustrates how a joint decision on aircraft types and equipment can further contribute to economies of scale:

> If a single airline decides to buy a single plane today, it will spend up to 30% of its initial purchase price on high-valued items simply to ensure uninterrupted operations. One single spare engine covering a fleet of five aircraft may amount to $8 million, depending on engine type. At the same time other spare parts, in particular avionic components, may easily add another $750,000 apiece to the investment. Whether a small fleet or a large fleet of aircraft is involved, the mix of engines and components is always similar. Consequently, larger corporations, or consortiums, can benefit from the economies of scale and reduce the amount of investment to a more sensible level (Carrington, Sept/Oct 1994, 15).

The concept of acquiring a common type of aircraft proved successful for many of the European airlines. Those who are willing and able to negotiate joint purchases of aircraft from manufacturers can benefit from discounts granted by the manufacturer that can run as high as 10% of the list price of the aircraft, and as much as 30% on the engine (Stomphorst, Executive Officer Engineering & Sales, ASL). Such a strong economic gain from a position of collective bargaining can equally be applied to the purchases of fuel, office equipment, ground vehicles, spares, and catering, and other on-going expenses.

Furthermore, the consortiums can save on the training for mechanics since the individual airlines no longer require engineers with multiple ratings. With a commonality of fleet, one specialist can handle more aircraft. Additionally, the planning procedures are greatly simplified and a high degree of familiarity with existing documents and their use is sustained. Joint ventures in maintenance have a definite edge over a single airline operating

and controlling its individual maintenance infrastructure. Overall service level for cooperative operations are higher compared to individual firms. As a result, dispatch reliability for pool members is increased compared to the single operator. At the same time the TRT for component parts can be greatly reduced, spending less capital on the required spare parts. The tangible savings for stock investment within a partnership can approach a level of $13 million per aircraft (Lufthansa, August 30, 1993, Germany).

The economic gains from forming partnerships are strong and make a good case; reduction in overall costs allows for stability in the airline cost structure. Still many airline executives are reluctant to embrace such a venture. The issue of control and safety seems to prevail, albeit, that safety seems to increase. The willingness to share information and facts about equipment failures aids in the prevention of further major safety problems. Finally, by working jointly, airlines can deliver new-entrant maintenance costs. Together with all the established expertise, this may well be an unbeatable mixture.

Northwest Airlines, for example, has set up pooling agreements with United Parcel Services (UPS) and UAL, as well as with its global partner Royal Dutch Airline (KLM). Economics show that such approaches have proven enormously successful. By pursuing this strategy, Northwest is able to increase the amount of inventory available to it with almost no additional cost. Within the period of 1992 to the end of 1994 the amount increased from roughly $18 million to $38 million (Flint, September, 1995, 107).

The concept of alliances seems feasible for all the world's airlines, in particular for third world country airlines, as they may reap greater benefits from close regional cooperation in areas such as shared purchasing, shared maintenance facilities and the centralization of training in the wake of changes in the regulatory policies governing the West. Consequently, third world country airlines may be able to run financially viable operations and close the gap in the technical skill levels, as well as the gap in marketing and economic power.

CONCLUSION

There is no one optimal solution as to the choice of how costs for aircraft maintenance can be managed and contained. Each individual airline needs to examine its particular circumstances such as fleet mix, city pair markets, geographical location, organization structure, cost structure, technical capabilities, and engineering expertise. In non-regulated, non-technical environments, logic implies that cost savings can be achieved by simply right-sizing operations. However, each situation demands a radical and atypical conclusion.

Traditional approaches of cost savings have been applied to the maintenance department with less than satisfying results. Several internal and external factors have altered what were formerly easy maintenance tasks into difficult and demanding operations, while old systems and processes have been slow to change. Modification of the procedures can and should only take place slowly and in measured increments.

Recognizing the resistance to change, but realizing the strengths of several different strategies within the peculiar environment, and the need to rationalize costs, each airline can find its optimal solution. Employing its own unique strategy, the individual airline is then capable of establishing a competitive base from which to operate and compete.