CHAPTER 3

OVERVIEW OF AIRCRAFT MAINTENANCE ORGANISATION

3.1. BACKGROUND

The case organisation is an engineering department of an international airline, which is in charge of aircraft maintenance for its main airline's own fleet and for the external customers. It was established, at the same time as the main airline, since 1960, and has steadily grown in importance as a leader in aircraft maintenance in the region. It is widely known as provider of aircraft-related technical services.

Since 1985, the case organisation has had extended capability for aircraft, engine and components overhaul and has become one of the most advanced aircraft maintenance centres in the region to meet the increasing numbers of aircraft.

In 2001, the board of directors of the main airline announced its resolution for re-structuring of the management organisation. The Executive Management of the main airline consequently proposed a scheme with the aim of enhancing competitiveness within the rapidly changing climate of the airline business. The Strategic Business Unit (SBU) for the non-core airline services (supporting activities) was then established.

The case organisation, or an airline engineering department, was the first strategic business unit of its airline. For its establishment as the strategic business unit (SBU) the vision of being the 'first choice - world class aircraft maintenance, repair and overhaul facilities' was created. It has formulated out of the main airline's experience servicing top ranking international airlines from around the globe.

The reputation for fast, reliable service is made possible by a huge inventory of components, a vast array of nearly every spare part, avionics and navigational elements, and engineers licensed to maintain and repair nearly every aircraft types used by international airlines today.

In 2002, the case organisation conducted 38,221 maintenance services on its main airline's own fleet and 2,564 services on aircraft belonging to the fleets of other airlines. It carried out 58 overhauls for its main airline and 16 overhauls for the fleets of leading airlines from Europe, North America and Asia.

The case organisation is committed to provide quality and reliable maintenance service is the top priority, as it relates directly to the safety and comfort of the passengers. To achieve this, they provides the maintenance service by utilising the most advanced technology and equipment, in combination with competence, well-trained personnel and the implementation of systematic quality assurance.

3.2. VISION AND MISSION STATEMENT

Vision:

The board of directors defined the vision statement under the following conditions:

- Stating 'what we want to become'
- Short, clear and concise
- Inline with the main airline's vision statement

The final selection of the vision statement by consensus of the working group is:

"TO BE THE FIRST CHOICE WORLD CLASS AIRCRAFT MAINTENANCE, REPAIR AND OVERHAUL FACILITIES"

The key words composing the vision are:

- First Choice which denote that the statement would be relevant to the main airline's vision statement.

- World Class which signify competitive quality level in the global maintenance, repair and overhaul (MRO) market.

Missions:

Technical Department is committed to deliver products and services with uncompromising safety and the highest quality, together with sustainable environmental friendly standards. The products and services delivered will

- Meet all Aviation Authority requirements and regulations
- Comply with relevant environmental laws, legislation and regulations
- Common to the Alliance safety and environment standard
- Fulfil the wishes and expectations of the customers
- Pose as least environmental impact as the available technologies can facilitate.

From the above commitments, the missions of Technical Department are defined as:

- Provide excellent quality aircraft maintenance, repair and overhaul services.
- Committed to comply with regulations and requirements in order to sustain highest safety, quality and environmental standard.
- Ensure that customer needs are responded and satisfied.
- Promote employee's satisfaction and participation.
- Maximise the use of available resources and technology.
- Strive to be competitive
- Be responsible for the society and the nation.

3.3. ORGANISATIONAL CULTURE

The organisational cultures are derived from the departmental top management which can be listed as follows:

- Customer focusing
- Accountability
- Team based operation (organisation)
- Information sharing
- Sense of ownership
- Accepting and adapting to changes
- Good governance

3.4. RANGE OF SERVICES

The aircraft maintenance, repair and overhaul (MRO) services can be classified into six groups as follows:

A. Line Maintenance:

With more than 40 years experience in the air and on the ground, the case organisation is the most capable, most centrally located maintenance facility in the region. As the main base operator at Bangkok International Airport, providing 24-hour-a-day routine and emergency service for most of the more than 55 European, North American and Asian airlines that call at Bangkok.

Our reputation for fast, reliable service is made possible by a huge inventory of components, including GE (CF6-50 and CF6-80) and PW4000 engines, a vast array of nearly every spare part, avionics and navigational elements, and engineers licensed to maintain and repair nearly every aircraft type used by international airlines today.

B. Light Maintenance:

Light maintenance is conducted on a wide variety of aircraft types including Airbus A300-B4, A300-600, A310, A320, A330, A340, Boeing B737, B747, B757, B767, B777, DC-10, MD-11, ATR42 and ATR72. Licensed aircraft engineer, available round the clock, provide full "A" check maintenance for the latest aircraft, making Bangkok an ideal place for an airline to schedule overnight stays for its aircraft.

In addition to emergency repairs, the technicians can also carry out all the non-emergency maintenance which an aircraft would normally have to return to home base to obtain. The technicians have at their fingertips, a stock of GE (CF6-50 and CF6-80), PW and RR engines, navigation, avionics and other components, and the huge inventory of nearly every spare part. A large personnel roster enables the case organisation to concentrate technicians on special jobs to get the plane back in the air in the shortest time possible.

In keeping pace with Bangkok's growth as a regional aviation hub, Light Maintenance Facilities now include a double bay and a single bay enabling the case organisation to handle several aircraft at the same time.

C. Heavy Maintenance:

The core activity of our case organisation is Heavy Maintenance. The recently expanded facility includes additional bays to test and repair or overhaul airframes, engines, hydromechanical and IERA components, and interior fittings for the new generation of aircraft now flying in today's fleets.

Case organisation now have the expertise and facilities to carry out D-checks for all Boeing B747, B737, B777 series and Airbus A300 series from stripping them to their main structures, modification and repairing structural members, to engine overhaul, and hydromechanical and IERA testing and repair.

Moreover, the case organisation are equipped and certified to carry out Section 41 modification, as well as crew rest area modification above the rear sections of Boeing B747 series. They are also certified to conduct Lapjoint modification for Airbus A300-B4.

The most advanced facilities, Maintenance Centre workshops to conduct non-destructive tests on structural elements, diagnose and repair on-board computers and other electronic and navigational equipment , and even repair upholstery, fibreglass, sheet metal and other components.

D. Component Overhauls:

The maintenance of hydromechanical, computer, electronic, and avionics components is one of the biggest, most expensive concerns for today's airlines. Airlines need a comprehensive facility capable of maintaining components to international standards while offering the lowest price possible.

Case organisation is capable of handling maintenance requirements for most Boeing, Airbus, and McDonnell-Douglas models, with special competence in Boeing and Airbus aircraft which comprise the bulk of our fleet.

E. Engine Overhauls:

Case organisation is rapidly gaining recognition as one of Asia's experts in overhauling General Electric Engines. Its main airline relies on GE engines to power its fleet of more than 60 aircraft.

The case organisation is the first Asian airline to use high-thrust CF6-50 engines, and have developed the technical competence to carry out most repair. Also the launch customer for the A300-600 with CF6-80C2 engines and can conduct repairs up to level of overhaul

The technical competence is founded on a staff fully skilled in handling every repair problem. Mechanics receive training at the manufacturers' plants, as well as on-the-job instruction at the leading CF6-50s and CF6-80s overhaul facilities, to gain on-line experience.

In the engine repair shop engine is striped into its smallest components, then utilise the latest Digital Electronic Automation three-dimensional measuring equipment to conduct diagnostic tests. The non-destructive testing methods are introduced including ultrasonic, eddy current for material inspections.

In the workshops, they chemically and mechanically clean, repair, and/or create all parts, or replace them from our inventory of 200,000 line items. They can plasma coat metals using an advanced model molten spray robot. MacrometII is used to test hardness of metal component surfaces. Among our precision equipment is the biggest Vertical Turret Lathe ever made. The one-storey tall lathe can cut and trim metal pieces to a maximum diameter of 2.6 metres.

On site is a test cell capable of generating a maximum thrust of 150,000 pounds. This modern facility enables us to run General Electric and Pratt & Whitney and RR (Rolls-Royce) engines to full power while executing computer control checks using programmes developed by engine manufacturers. In it, they test FADEC engines and replace their components. There is also a small shaft cell to test gas turbine engines using computerised test equipment.

F. Calibration Service:

The calibration laboratories in Group of Reference Standards Laboratory at case organisation have been in operation since July 1986. The laboratories were designed to provide the calibration and maintenance facility capable for supporting complex electrical and mechanical test equipment associated with the maintenance of Airbus A300, Boeing B737, B747 and some other new types i.e. Airbus A330 and Boeing 777.

Calibration tasks are conducted and complied the requirements in accordance with ISO/IEC Guide 25, ISO10012, ISO-9000 and also recognized and accepted by authorities which Case organisation are holding their special type of certificates for aircraft repair station such as Federal Aviation Administration (FAA) USA and Joint Aviation Authorities (JAA). A quality assurance program is implemented in the Laboratory to confirm the competence and correlation coefficient of the measurement by succession auditing and holding accreditation certification of Calibration No. 0003 from a well established national accreditation body, Thai Laboratory Accreditation Scheme (TLAS) Thai Industrial Standards Institute, Ministry of Industry since 28 MAY 1996 in the Electrical and Dimensional measurement activities.

3.5. AIRCRAFT MAINTENANCE MANAGEMENT

3.5.1. Airline Economy

According to Friend (1992), to ensure safety, airlines must keep their aircraft in good condition. A maintenance scheme is negotiated with the local government air-safety regulating body, based on recommendations made by the aircraft manufacturer and the experience of the airline and regulatory authorities. This covers everything from routine servicing before every take-off to major overhauls done every few years.

The fundamental cost relation for passenger-carrying flights is the cost per seat-km. expressed as a function of route length. Friend (1992) classifies the consequence of several factors:

1. Payload – Range:
2. Block Speed:
3. Aircraft Output:
4. Costs:

By focusing on 'costs', which is further affected by the actual aircraft utilisation which can be achieved, and by the division of aircraft costs between those which remain fixed in relation to flying rate and those which vary directly with flying.

Maintenance costs range from 10 percent to 20 percent of the total aircraft operating cost. Newer aircraft have lower costs than older ones because they have not reached the major overhauls age yet. Aircraft maintenance requires heavy investment in hangars, workshops and other equipment. Small airlines may therefore contract their maintenance to larger airlines or to experienced overhaul organisations.

Maintenance costs can be reduced by continuous monitoring of the aircraft condition, so that unnecessary work is avoided or by incentive contracting to encourage profit sharing with a supplier.

3.5.2. Cost of Aircraft Maintenance

Aircraft maintenance costs are expected to depend on the type of aircraft and the kind of operation for which the aircraft is use. To illustrate these effects for civil aircraft, consider the results reported for operators as quoted in quarterly statistics published in magazines such as Aviation Week, Space Technology or Air Transport World.

Friend (1992) further states that a measurement of maintenance cost often used by operators is the ratio of maintenance manhours to aircraft flying hours. This is useful for first estimate in budgeting, and is also used as a target in military aircraft procurement contracts. Cost figures expressed in money are affected by inflation and exchange rate fluctuations where as manhour figures are not subjected to these

influences. Manhours can, however, be influenced by training, experience, and technological changes.

Other measures of maintenance cost are from the IATA Report. Looking at results for the top 24 carriers measured by total employee, it is seen that maintenance and overhaul employees were typically from 14 percent to 24 percent of the total, which some notable exceptions.

According to Friend (1992) *"maintenance, repair and overhaul is thus still a significant part of most airline's activity, despite the growth of staff in other areas of the airlines and the increasing reliance on independent aircraft-maintenance organisations."*

As a perspective on the share of the total airline operating expense taken by engineering, consider the figure reported by one airline. These show that engineering is a lower cost category than selling, for instance.

Although aircraft are expensive, airline are not 'capital intensive'. The largest single cost category is for staff.

3.5.3. Technical Measures for Maintenance Reliability

Although aircraft reliability can be specified and measured exactly using the foregoing terms, it is not always useful in management action towards identifying problems. Other measures frequency used are:

- Pilot reports of technical defects;
- Engineers' reports of technical defects;
- Average level of deferred defects carried;
- Average time to clear deferred defects;
- Time off service for repairs;
- Usage of standby aircraft or slack time in the schedules;
- Maintenance manhours per flying hour;
- Maintenance cost per flying hour.

Of the measure described, airline operators usually attach great importance to schedule reliability, since this most closely corresponds to the performance offered to the travelling public, namely a promise to convey the passenger in accordance with the published timetable. Pilot reports per flight or flying hour are often used internally by company management as an indication of potential trouble. The actual figures will be affected by crew policy, since pilots are bound to notify defects when they complete a duty on the aircraft. If this happens after every flight, the incidence of reports will be high. Monitoring of the deferred-defect rate and clearance is required by airworthiness authorities.

Attempts to measure aircraft reliability by time out of service for unscheduled repairs are made difficult by the effects of aircraft utilisation. If the aircraft is scheduled for an intensive flying rate, as is often the case with new types, a small comparatively small amount of down time will cause aircraft shortages and schedule interruptions.

If the aircraft is not scheduled intensively, more time is available for maintenance and staff man react by giving completion a lower priority than for other aircraft types.

Maintenance manhours per flying hour are measured for long term trends and for planning purposes. Maintenance costs are monitored for budgetary purpose as part of accounting system. Some components and systems on new aircraft have specific contract targets set for these costs whilst under warranty. Component unscheduled removal rates are measured by reliability programme in many airlines. Confirmed defect rates or the complement 'no-fault found' rates are used as a measure of maintenance diagnostic accuracy by many operators.

The airline engineering and maintenance requirements are described under several headings:

1. Engineering Modifications: Modification particular to EROPS must be identified to the authority. Assessment should consider their impact on these operations.
2. Maintenance and Training: Procedures, practice and limitations established for EROPS should be approved.
3. Reliability Reporting: A programme should be developed before approval and continued afterwards. Regular reports must be sent to the authority and manufacturers.
4. Modifications and Inspections: Procedures for prompt implementation of modifications and inspections affecting propulsion system reliability must exist.
5. Aircraft Despatch: An aircraft should not fly an extended range operation after power unit shutdown or primary system failure has occurred on a previous flight, or after significant adverse trends in system performance, unless appropriate corrective action has been taken. A successful flight subsequence to the corrective action may be needed to confirm this.
6. Maintenance programme: The operator must ensure that aircraft, engine and equipment reliability are maintained at the level required for EROPS.
7. Engine Condition Monitoring: This must be developed, and may included hard-time inspection intervals for component condition not observable and which may be affect failure rates.
8. Oil Consumption: This must be monitored for engines, and for the auxiliary power unit as that is part of the emergency power system.

Note: EROPS is the extended range operations which mean operations beyond the original safety limit of flying time to the nearest airfield, with an engine failure.

A maintenance programme should contain the standards, guidance, and direction necessary to support the intended operations. Maintenance personnel involved should be made aware of the special nature of EROPS and have the knowledge skills and ability to accomplish the requirements of the program.

3.5.4. Budgetary Controls

In business particularly where competition sets prices effective use of resource and control of costs is essential to profits and survival. Control means communication about plans, motivation of people to perform work, and measurement of performance. The process must recognise the responsibility of managers and provide with the tools to achieve this. Business organisation nowadays functions by dividing the company into cost centres for accounting and reporting purposes. These centres often correspond to physical areas such as workshops, hangars, or servicing centres in aircraft maintenance, but they can also apply to staff functions such as quality control, information technology, and safety group.

Budgetary control is one important part of the planning process. In a modern business, budgets are made to support requests for manpower, materials, and capital equipment needed to carry out the work specified in the operating plan. In an airline, it is vital to be able to relate these to the anticipated volume of output measured in aircraft hours, because sudden unexpected changes in demand may occur as a result of economic or political forces in other regions of the world. Diverting production to other parts of the world as a response to disappointment in one area is not always possible in air transport industry.

Operating budgets are usually tied to the financial year, and accountants then collate them, together with an estimate of total revenue, to forecast profitability. This often means that several attempts at establishing a budget for forthcoming year are needed to obtain a satisfactory result. Once set, the budget for a manager or section is used to monitor expenditure and to decide action if deviations from the plan arise. Items such as significant capital expenditure on new building require longer time-scales and are treated separately.

Although budgeting in accounting subjects is largely concerns with measurements in money, it may include performance statements about quality of service, such as on-time delivery, average turnaround times, or other non-monetary events. In theory these can be costed with the aid of further research, but arguments over attributing charges can be difficult to follow, and many senior managers prefer single-figure targets which everyone in the organisation can understand. Example are the late delivery of aircraft after maintenance checks, the proportion of spare parts demands met by workshop within one week, and the percentage of departures delayed for engineering reasons attributed to different aircraft system. Some of these are intended to act as checks on the financial targets, a workshop could achieve lower costs by arranging incoming work into batches, but this would adversely affect the supply reliability, a hangar manager could overspend on resources to guarantee early finished, but this would increase operating costs.

Planning is based on agreed standards for times and costs of routine tasks, derived from historical records. However, management often wishes to see improvements in certain areas, so a process of negotiation over acceptable targets may take place. Introduction of new working practices might change some job times, purchase of new equipment on the effects of changes, an internal technical specialist may be

asked to volunteer a claim for the improvement in the standard. In this way, a development engineer could give an estimate for the effect of a modification on failure rate or material cost. This is inevitably rather subjective, but helps to commit people to realising the objective.

3.5.5. Inventory Management

Inventory Cost:

All airlines are now turning their attention to reducing inventory costs by minimising stocks of spare parts held. Once, it was common to estimate how many spares would be needed over the life of the aircraft and to buy them with the aircraft, for a cost up to 15 percent of the new aircraft price. As the expense of doing this increased, buying parts in instalments after fleet delivery was tried. This relies on the fact that some maintenance is not needed in the early years of an aircraft's use, and also allows for some adjustment to purchases after experience of their actual usage rates. This scheme fails if the aircraft's sales are so poor that the equipment suppliers curtail their investment in it.

More recently operators have begun to require manufacturers to assume more responsibility for reliability and cost of parts in these early years of use. Three year fixed price contracts, during which the actual economic performance will be established before transfer to operator, are not common (Friend, 1992).

In United States, the Air Transportation Association (ATA) has set up ATA Specification 2000, as a database of aircraft parts available inline to operators. This gives details in a standard format, and will eventually enable paperless transactions to be conducted. ATA also has a project called Airline Inventory Redistribution System (AIRS), which lists parts surplus to a carrier's needs. Airlines could use this to dispose of unused parts if a buyer is found.

Other solution proposed for the airline-spares inventory problems are: (Friend, 1992):

- selective provisioning for different shortage risks;
- better forecasting models;
- more use of real-time computer systems;
- 'just in time' material management philosophy;
- Manufacturer's spares depots.

British Airways' engineering inventory is valued at about £375m. For comparison, the airline's total annual operating expenditure under all heading is about £4,000m. The main inventory categories are expendable (use once and then discarded) or rotable (may be restored by repair). There are further divisions within these categories. Rotable parts may have serial numbers which enable the actual part to be identified physically and recorded in a computer system.

Processing of Spares:

An operator will have at least one warehouse to handle all spares and material for the company, both ingoing and outgoing items. The central receipts despatch area has to deal with various kinds of inventory items which may be (Friend, 1992):

- expendable;
- rotable;
- contract;
- loans;
- new purchases

All of this must be checked for compliance with quality control requirements in addition to the normal business activity of any engineering company. Most operators use computer based stock control system to manage their spares and material, but the system used by airline may differ from those common in other production or distribution industries. Once reason for this is the large number of distinct parts involved in aircraft maintenance work. Another important reason is the requirement for a maintenance or ownership history of the parts to be kept.

Friend (1992) comments that spare pools are operated by users of common aircraft types. This reduces the need for every operator to locate spares at stations away from the main base. In the pool, each operator is designated as the major supplier at his base, and if another operator needs a spare at that station it is borrowed to get the aircraft back to its main base. The loan unit is returned as soon as practically possible to its owner. In this way cost of spares to each operator is reduced.