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AVIATION SPARE PARTS SUPPLY CHAIN MANAGEMENT OPTIMISATION AT CATHAY PACIFIC AIRWAYS LIMITED

We have 2½ billion Hong Kong dollars worth of spare parts on our shelves. Managing these spare parts effectively is instrumental in ensuring the efficient operations of our airline. This presents a significant challenge to the engineering department.

- Robert Taylor, manager of inventory operations, Cathay Pacific[1]

A profitable and financially sound commercial airline, Cathay Pacific Airways Limited had every reason to be proud. It was voted "Airline of the Year" in the world's largest passenger poll, conducted by Skytrax Research in 2005, and named "Airline of the Year" by *Air Transport World* magazine in 2006.[2] However, there was an operational pain that continued to bother Cathay Pacific. In March 2007, Robert Taylor, manager of inventory operations, and Paul Barwell, manager of procurement of aircraft components and maintenance, were requested to head up a task force to optimise the supply chain management of spare parts operations at Cathay Pacific. Aviation spare parts constituted a significant expense in Cathay Pacific's financial statements. From the balance sheet perspective, as of December 2005, the total inventory value of all aviation spare parts amounted to over US$350 million. Dead and inactive stock accounted for 3% per annum and was an issue to manage with care due to obsolescence and unpredictable demand patterns. Supply chain management for aviation spare parts was complex because of the need to ensure timely service availability of a huge variety of stock and to comply with stringent quality and regulatory requirements.

[1] Company interview on 25 July 2007.
[2] For details, see Cathay Pacific's website: http://www.cathaypacific.com.

Karen Lee and Jonathan Pelosi prepared this case under the supervision of Benjamin Yen for class discussion. This case is not intended to show effective or ineffective handling of decision or business processes.

Ref. 09/382C

> *A bolt for a desk chair costs a dollar. The same bolt for a chair on an aeroplane would cost 30 dollars. It is that magnitude of difference. Everything for an aircraft is massively expensive.*
>
> - Paul Barwell, manager of procurement, Cathay Pacific[3]

The challenge for the management team was to explore alternatives for optimising spare parts supply chain management and instigate process improvement.

The Aviation Spare Parts Industry

Managing spare parts in the aviation industry had always been a challenge for airline operators because the aviation supply chain was unusually complicated. The aviation industry was regulated by international and local authorities such as the US Federal Aviation Administration ("FAA"), the European Aviation Safety Agency ("EASA") and the Civil Aviation Department of the Government of the Hong Kong Special Administrative Region. Mechanics certified by the FAA were required to check all non-deferrable repairs before a plane's departure and verify that all regulations were met. In addition, the FAA had the authority to ground a plane if airline operators did not complete the deferrable repairs within the stipulated timeframe.[4] All suppliers of aeroplane spare parts were required to possess special legal certifications and formal protocols, which were stipulations that indicated assumption of responsibility in case of an accident. Turnaround time for repairs was critical, as highlighted by measurable and non-measurable costs. In addition to standard passenger compensation for flight delays such as hotel accommodation, it cost US$60 per minute to keep an aircraft on the runway.[5] Moreover, there existed a risk that customers might be upset or even shift to other airlines if delays caused them to lose their connecting flights. Therefore the cost of aircraft delays was a key decision making element in engineering.

Aviation spare parts themselves were also expensive and complex. To illustrate, the average cost of an engine was US$12 million and comprised thousands components and assemblies ranging from nuts and bolts to ten thousands. In addition to manufacturing expenses, the high costs were attributed to regulatory and testing requirements of spare parts for reliability. The variability of aeroplane spare parts, coupled with the sporadic nature of demand for aircraft maintenance repair parts, made spare parts demand forecasting more difficult, necessitating increased manpower.

Buyer's Market

The carrying costs for aviation spare parts inventory were relatively expensive. Future demands for spare parts were made based on maintenance information, scheduled maintenance plans and past usage patterns such as flying hours or parts demand. However, the usage pattern of spare parts remained highly unpredictable because of the high level of demand variability. It was reported that 30% of the inventory of a traditional airline was active, another 30% was slow-moving but necessary to have on hand and the remaining 40% was dead stock.[6] It was estimated that the airline industry spent over US$10 billion per year on spare parts, of which 10% came from airlines' and overhaul agencies' pre-owned stocks.[7] The value of spare engines for major airlines was estimated at over US$11 billion and the

[3] Company interview on 25 July 2007.
[4] Sachon, M. and Paté-Cornell, E. (2000) "Delays and Safety in Airline Maintenance", *Reliability Engineering and System Safety*, 67 (3), pp. 301–309.
[5] Company interview on 25 July 2007.
[6] Harrington, L. (2007) "From Just in Case to Just in Time", *Air Transport World*, 44 (4), pp. 77–80.
[7] Doug, B. (2000) "Spares Apart", *Aerospace International*, 27 (6), pp. 14–17.

overall value of spare parts stored by the airline industry had increased from US$45 billion in 1995 to US$50 billion in 2002, of which 80% was owned by airline operators.[8]

Aircraft components were complex, high-level modules consisting of dozens or hundreds of parts. The life span of a component could exceed two decades, during which it might be repaired or overhauled more than a dozen times. These issues, combined with aviation authority requirements such as certification and traceability and issues of reliability and safety, increased the cost of obtaining and keeping aviation spare parts. Since the majority of the inventory value in the aviation supply chain was tied up in spare components, they represented the primary target for inventory value reduction.[9]

Supplier's Market

Similar to any other industry, price and quality were two major determining factors for airline operators in evaluating their spare parts suppliers. As a result of tight aviation regulations, airline operators, as customers, were constrained in supplier selection. Moreover, there were situations that were dominated by a single supplier, as with parts solely supplied by an original equipment manufacturer ("OEM"). OEMs were companies who were original manufacturers of a component for a product that might be resold by another company. The limited choice and high concentration of OEMs limited airline operators' negotiation power. Unlike consumable products, the criticality of the engine and the long usable life of an aircraft had contributed to strong resistance among airline operators to switch engine spare parts suppliers. Moreover, there was limited room to negotiate after an aircraft was purchased; the purchaser was now dependent on the OEM's products.

Because of tight regulations and dependence on OEMs, seeking alternative suppliers was a challenge for Cathay Pacific[10]. The supplier's market was concentrated in a handful of aerospace conglomerates, including Goodrich Corporation and Honeywell Aerospace. This was very much unlike the car industry, in which Volvo could choose from a number of suppliers to purchase a new engine for a new car. Joint purchasing activities amongst airline alliances to influence procurement processes were also likely to be opposed for anti-trust reasons. Joint purchasing activities pursued by airline alliances were deemed as similar actions undertaken by a conglomerate trying to influence the supply market. Strict regulations were in place, in countries like Australia, to govern the extent of joint purchasing activities allowed.[11]

To alleviate over-dependence upon single source suppliers, airline operators had begun exploring opportunities of sourcing certain categories of approved parts manufactured under a regulated program called "PMA" (Parts Manufacturer Approval). Through the PMA process these categories of part were generally available at more competitive pricing with reduced lead times.

Supplier selection was also influenced by whether the parts in question were new or old part models. Because OEMs were the original manufacturers, they were generally the preferred suppliers for new part models owing to their level of expertise in maintenance and repairs. For older, non-critical models, PMA suppliers were a viable option.

[8] Kilpi, J. and Vepsäläinen, A.P.J. (2004) "Pooling of Spare Components between Airlines", *Journal of Air Transport Management*, 10 (2), pp. 137–146.
[9] Kilpi, J. and Vepsäläinen, A.P.J. (2004) "Pooling of Spare Components between Airlines", *Journal of Air Transport Management*, 10 (2), pp. 137–146.
[10] Company interview on 25 July 2007.
[11] Company interview on 25 July 2007.

Company History

Cathay Pacific Airways was founded in Hong Kong on 24 September 1946 by two ex-air force pilots, American Roy Farrell and Australian Sydney de Kantzow. With a single Douglas DC-3 (a small passenger plane), Cathay Pacific launched its first routes between Hong Kong, Sydney, Manila, Singapore, Shanghai and Canton, with limited scheduled service to Manila, Singapore and Bangkok. In 1948, Butterfield & Swire, which later became the Swire Group, bought 45% of Cathay Pacific and had since then become the de facto flagship carrier of Hong Kong.

The 1960s to 1990s marked the development and growth era of Cathay Pacific [see **Exhibit 1**], owing to successful corporate strategy implementation in product innovation and to acquisitions. During the 1970s, Cathay Pacific had demonstrated its commitment to product innovation through its introduction of flight simulators and one of the industry's first computerised reservation systems. These technological investments further enhanced Cathay Pacific's service offering. In addition, Cathay Pacific had made timely acquisitions allowing the airline to become one of the world industry leaders. With access to capital markets for fund raising following their initial public offering in Hong Kong in 1986, Cathay Pacific pursued its plan of expansion into Europe and North America. Recognising destination reach as a critical factor for excellent customer service and acknowledging the increasing demand in China, in September 2006, Cathay Pacific not only integrated with Dragon Air but also enhanced its cooperative agreement with Air China. Cathay Pacific was also one of the founding members of the oneworld Alliance in 1998, a network of airlines designed to increase efficiency by offering nearly 700 destinations.[12]

Turnover in 2006 exceeded US$7.77 billion and profits surpassed US$523 million. Cathay Pacific employed over 25,000 staff worldwide, serviced over 43 destinations throughout Asia, North America and Europe and carried over 16.7 million passengers in 2006.

Spare Part Supply Chain Management at Cathay Pacific

> *Managing the inventory is tough. With the aviation business, the supply chain tends to be much more complicated compared to regular businesses. This is due to all the restrictions, the turnaround time, lead time, repair time, expensive components, how many should I keep on the shelf, my float level.*
>
> - Robert Taylor, manager of inventory operations, Cathay Pacific[13]

Cathay's Engineering Commercial section was made up of mainly three functions, Procurement, IOPs (Inventory Operations), and Planning [See **Exhibit 2**]. For the scope of spare parts management, IOPs was in charge of the day-to-day operation while Procurement took up the commercial responsibilities with suppliers. IOPs was operating on an annual budget of over US$450 million[14].

Owing to the diversity in the nature of parts and the fact that there were over 1,000,000 parts on a single aeroplane, there were over 380,000 line items in Cathay Pacific's database as of February 2007. Accordingly, there were over 2,300 suppliers to meet the spare parts demands of Cathay Pacific's fleet of over 117 planes consisting of 11 models with an average age of 11

[12] For details, see Cathay Pacific's website: http://www.cathaypacific.com.
[13] Company interview on 25 July 2007.
[14] Company interview on 25 July 2007.

years.[15] Another 46 planes, including three new models, were expected to be delivered in the next five years.

Spare Parts Classification at Cathay Pacific

Spare parts were dually classified according to their function and their criticality.

Spare Parts by Function[16]

Cathay Pacific's system divided airplane spare parts into five primary classes: rotable, repairable, expendable, consumable and expendable-repairable.

Rotables consisted of the most complex, expensive and longest-lasting parts of an aeroplane (ie, the engine). In addition, they included serialised assemblies, end items, line-replaceable units and units that incorporated repairable parts. Because they were assembled units, they could consist of parts belonging to the other four categories of spare parts, meaning rotables could be built from parts which were expendables or consumables. For example, an engine was a rotable component, but there were many different assembly parts inside the engine. Rotables were depreciable over time and had an extensive life expectancy through repetitive overhaul processes that would, under normal operating conditions, equal the life of an aircraft. Unserviceable units were normally routed to overhaul/repair shops for inspection, repair or overhaul and were recertified for serviceability based on authorised procedures.

Repairables included parts that were considered economically repairable and were continually rehabilitated in the normal course of operation to a fully serviceable condition over a period which was usually less than the life of the flight equipment with which they were associated. These parts were repaired until declared no longer of value because of obsolescence either of themselves or of the flight equipment to which they related, or because the assemblies had become damaged beyond repair. A fuel pump in the aeroplane was an example of a repairable part.

Expendables included both integral and non-integral parts of assemblies that were reused or replaced based on inspection findings. Some examples of integral expendables were dowels, pins and sleeves. Examples of non-integral expendables included bearings, springs, bulbs and brackets.

Consumables included replacement items that were discarded and replaced at each assembly overhaul pursuant to overhaul specifications and procedures. Examples of consumable parts were oil, chemicals, paints, fabrics and metals.

Expendables-repairables included any expendable that might be recovered through minor repairs, such as seat arm caps.

These five classes could also be addressed from two different points of view. The first was an inventory management perspective that focused on whether the units could be repaired or not. For example, rotables and repairables were components that could be repaired. The second perspective was that of accounting and focused on depreciable lifespan. Rotables, for instance, had a lifespan equal to that of an aircraft.

[15] Cathay Pacific's website: http://www.cathaypacific.com/cpa/en_US/aboutus/cxbackground/factsheet (accessed 14 May, 2008).
[16] Definitions taken from: Cathay Pacific (1 May 2006) "Engineering Procedure Manual Inventory Operations Volume 9A", Company Presentations.

Spare Parts by Criticality

Cathay Pacific further subdivided their spare parts by classifying the above five categories broadly into critical components and non-critical components, which could further be classified by the criticality codes 0, 1, 2, 3 and 4 [see **Exhibit 3**].

Critical components were parts that were essential to operating an aircraft safely and effectively. They could make the difference between a safe landing and a mid-air catastrophe. These parts were usually very expensive and complex. An example of a critical component was the US$1 million Electronic Engine Controller[17].

Non-critical components encompassed all parts of the plane that were not essential to the effective and safe operation of an aeroplane. There was a diverse range of non-critical components, from in-flight entertainment systems to nuts and bolts. Expendables and consumables qualified as non-critical components in the majority of cases. Nevertheless, there were instances where these types of parts were considered critical components, such as a dowel required to keep a rotable part in operational form.

The critical and non-critical dimension could be applied to all five classes of materials [see **Exhibit 4**].[18]

Current Practices in Aviation Spare Parts Supply Chain Management

The spare parts supply chain operations at Cathay Pacific flowed from procurement and inventory management to repair management and logistics management. Cathay Pacific's internal supply chain strategy had been driven by ensuring quality and service to the aircraft operation in the most cost efficient manner.

Procurement

The supply chain of spare parts at Cathay Pacific was a very complex, large-scale operation with thousands of suppliers and distributors. Aviation spare parts were handled and directly purchased by Cathay Pacific. The purchasing activities were transaction-orientated, from sourcing and storage to consumption and repurchase. Cathay Pacific's procurement process could be triggered by normal replenishment, initial provisioning or special provisioning [see **Exhibit 5**]. In line with the nature of the business, Cathay Pacific had to ensure that adequate airworthy spare parts were available at all times. In addition to purchasing activities, the procurement process involved Cathay Pacific's cross-functional teams in selecting, monitoring, evaluating and managing relationships with part providers to ensure operational effectiveness. Key performance indicators were set as quantifiable objective measures to assess the quality and the performance of the parts. Some of these measures included average and variance of lead time, quality levels and component performance.

The airline industry had very few choices for critical parts component suppliers. Moreover, the sensitive nature of these critical parts limited Cathay Pacific's ability to switch suppliers because of the significant costs associated with switching.

There was a greater level of flexibility for non-critical spare parts, with over 200 consumables and expendables suppliers. This, however, had, consumed much of Cathay Pacific's resources in managing supplier relationships.

[17] An electronic engine controller is used to monitor and control the operation of the engine
[18] Cathay Pacific (1 May 2006) "Engineering Procedure Manual Inventory Operations Volume 9A", Company Presentations.

Inventory Management

> *Inventory management for Cathay Pacific is determining the right quantity of spare parts and material at the right time and at the right place to meet anticipated and unanticipated demands to maintain aircraft operations at the desired service level at the optimal costs*
>
> - Engineering Procedure Manual, Cathay Pacific

Monitoring of stock turnover, which was an indicator of the efficiency of stock management, was thus an integral component of Cathay Pacific's inventory management process. Timely stock replenishments were needed once reorder points were reached. An extensive system, Ultramain, was in place for management of components replacements and newly acquired spare parts [see **Exhibit 6 and 7**].

Cathay Pacific also needed to minimise inventory holding costs. In theory, an exhaustive inventory was needed to reach a service level that could satisfy all the possible demand of its aircraft. Because this was financially and operationally infeasible, Cathay Pacific had to operate in the most economically responsible way and strike a balance between the most effective inventory levels to hold on to relative to the corresponding service level.

To guard against the risk and cost of prolonged downtime, Cathay Pacific normally built in a buffer stock and, as a result, additional cost was incurred to engineering operation in general. Despite Cathay Pacific's efforts to manage their spare parts inventory in an optimal manner, they still encountered circumstances where a certain part was needed and no stock was available. Coping with such a situation was referred to as "shortage management". Shortage management was a process of sourcing parts that, for one reason or another, were unavailable to meet the expected demands.[19] When Cathay Pacific required a spare part immediately and none was readily available, they explored several options to meet the urgent need:

- Aircraft-on-ground ("AOG") orders were employed in situations where a Cathay Pacific plane was grounded and could not take off without a certain part. When an AOG order was placed, the part would be shipped via same-day express delivery.
- Cathay Pacific could retrieve the necessary spare part by borrowing it from another airline.
- Pool loans were another way Cathay Pacific was able to manage part shortages. By signing a contract with the International Airline Technical Pool, Cathay Pacific was granted access to a network of over 100 airlines with which they could share spare parts when in need without incurring a surcharge.
- Cathay could also borrow a part from one of its other aircraft.

Repair Management

On average, Cathay Pacific managed over 80,000 repair orders per year, or over 7,000 repair orders per month.[20] After determining whether faulty parts were repairable or not, Cathay Pacific had to determine whether their existing repairers had both the required capability as well as necessary capacity to repair the full range of components installed on its aircraft. To this end, Cathay Pacific compiled a database of over 300 of the world's major aeroplane spare part repair shops. Repair shops were selected based on the types of spare parts the shop specialised in, quality, price and service level.

In 2000, Cathay Pacific collaborated with 13 other airlines to develop Aeroxchange, a system designed to facilitate the sharing and exchange of information, such as repairer sourcing,

[19] Company interview on 15 December 2006.
[20] Company interview on 15 December 2006.

between the participating airlines [see **Exhibit 8**]. Information such as the types of spare parts availability and suppliers lists was available through the Aeroxchange program,

Cathay Pacific forecasted future demand for components on projected fleet utilisation and an individual component's life cycle. However, this only represented part of the picture as the method lacked the ability to forecast demand arising from unscheduled removals, which counted for nearly 79% of all removals. .

Logistics Management

Given that appropriate quality and quantity of inventory was available and that the inventory was processed and repaired accordingly, effective supply chain management was dependent on effective logistics management. Logistics management in this context was the practice of minimising the duration and number of processes required to transport spare parts from one place to another. Cathay Pacific's logistics management arm was responsible for managing the shipment of ordered inventory from warehouse to aeroplane as well as to and from the repair centres. In order to reduce lead times, Cathay Pacific usually shipped parts individually between repair houses and Cathay Pacific hubs. However, in order to minimise costs, Cathay Pacific consolidated shipments of spare parts that were less sensitive to lead times. In Australia, for example, a fixed import tax was charged on every shipment. Cathay Pacific would therefore weigh the time and costs associated with allowing several spare parts to be accumulated for the purpose of consolidating them into one shipment.

Cathay Pacific outsourced to third-party logistics companies to transport their unserviceable parts to various repair houses across the globe. This outsourcing approach allowed Cathay Pacific to capitalise on the expertise possessed by the logistics partners in shipping and handling fragile parts, which in turn generated cost savings to Cathay Pacific. Due to the high level of sensitivity of some of the spare parts that were transported, Cathay Pacific conducted extensive due diligence on potential logistics prior to establishing relationships. Factors considered included: satisfactory previous shipping record; the appropriateness of licenses and insurances held by the logistics companies; transportation networks of the logistics companies; and extent of performance reviews.

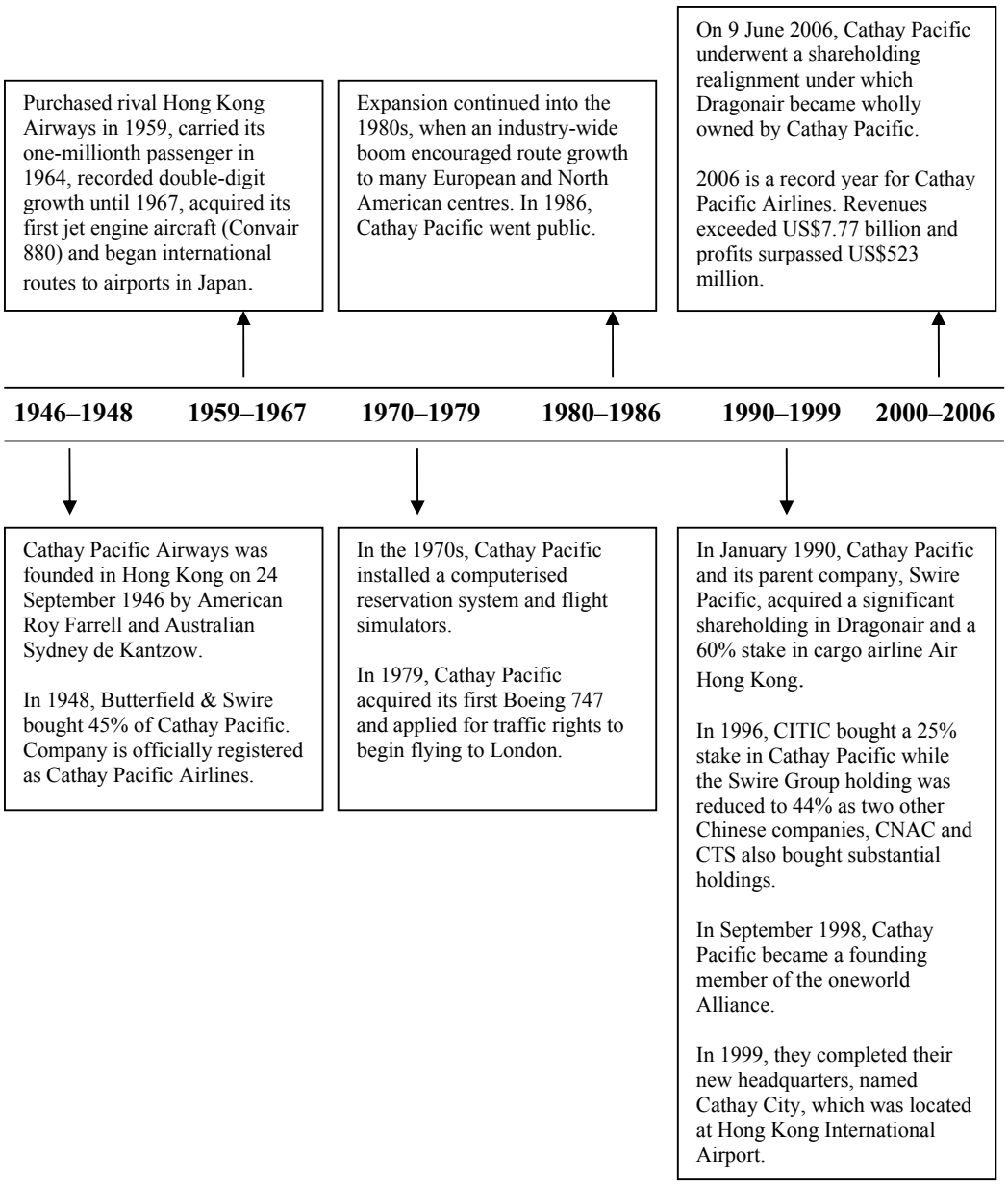
Reducing spare parts inventory level depended on reducing the lead time from suppliers and turn around time from repair shops. Through the just-in-time practices,[21] Cathay Pacific attempted to balance quality service with minimal inventory levels in order to generate the lowest inventory holding costs possible.

Supply Chain Management Optimisation Proposal

Although Cathay Pacific was known to be one of the most profitable airlines in the world and well positioned for future expansion, it was critical for Cathay Pacific to maintain its competitive position in the cutthroat airline industry by examining ways of reducing operating costs while improving customers' flight experience. Cathay Pacific was challenged by the need to manage at least 380,000 spare parts and over 2,300 suppliers. Should the company devote more internal resources to the endeavour or collaborate to a greater extent with third-party logistics service providers? Was the solution to invest more heavily in both? .

[21] Just-in-time systems organize materials to arrive just as they were needed. Just-in-time practices co-ordinated the supply and demand of materials. (Waters, D. (2003) *Logistics – An Introduction to Supply Chain Management*, Palgrave Macmillan: London, p.179.)

EXHIBIT 1: CATHAY PACIFIC TIMELINE, 1946–2006



Source: Cathay Pacific's website:
http://www.cathaypacific.com/cpa/en_INTL/aboutus/cxbackground/history (accessed 14 May, 2008)

EXHIBIT 2: ORGANISATION STRUCTURE OF CATHAY PACIFIC'S ENGINEERING COMMERCIAL DIVISION

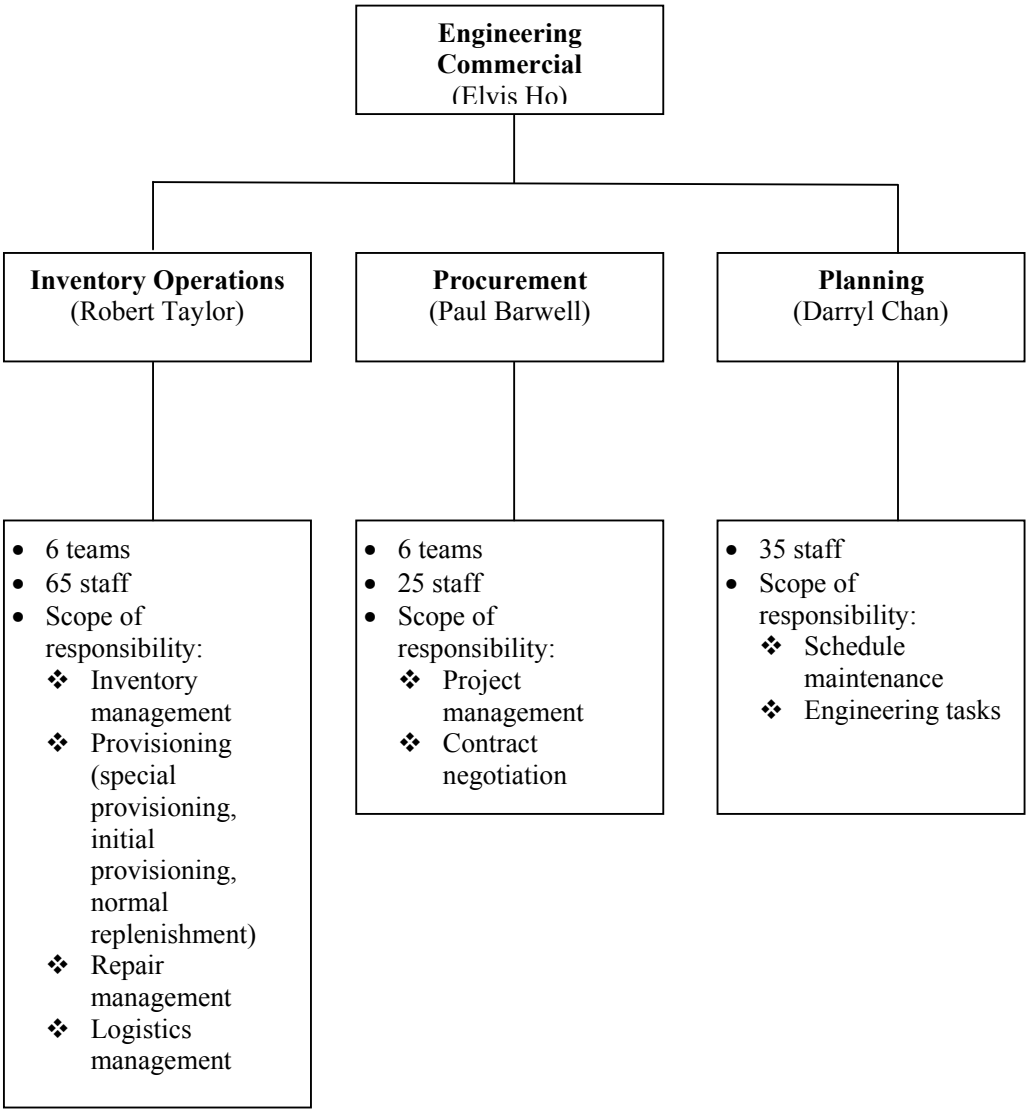


EXHIBIT 3: EXAMPLES OF INVENTORY CRITICALITY

Criticality codes were numeric codes that identified the level of criticality an item held from a maintenance perspective. Cathay Pacific referenced their supplier's Recommendation Spare Part List and its product characteristics in order to determine the criticality code. For example, an extended twin engine operation was classified as critical level 1, which meant the subject aircraft could not be allowed to take off.

Definition of Criticality Codes
Criticality Code 1: No Go
Criticality Code 2: Go If
Criticality Code 3: Go
Criticality Code 4: Workshop
Criticality Code 0: N/A

Technical Spare Parts

Type	Criticality Level
AOG, ETOPS, MEL (Cat A, B, C)	1
MEL (Cat D)	2
Others	3
Workshop	4
Mod Kit or Program Kit	0

AOG = Aircraft on Ground
MEL = Minimum Equipment List
ETOPS = Extended Twin Engine Operations

Denotes importance in aircraft maintenance

Cabin Spare Parts

Type	Criticality Level
F/B Class Passenger Sensitive (Significant)	1
F/B Class (Non-Significant), Y-Class Passenger (Significant)	2
Y-Class Passenger (Non-Significant)	3

Source: Cathay Pacific (1 May 2006) "Engineering Procedure Manual Inventory Operations Volume 9A", Company Presentations, p. 10.

EXHIBIT 4: MATCHING CRITICALITY WITH INVENTORY CLASSES

Criticality	Definition	Class C/E/ER	Class R	Class T
1	MEL Cat ABC, AOG, ETOPS, FJ Pax Significant	6%	15%	21%
2	MEL Cat D, FJ Pax Non-Significant, Y Pax Significant	3%	12%	26%
3	Others/Y-Class Non-Significant	82%	71%	54%
4	Workshop	6%	0%	0%
0	Mod Kit/Program Kit	2%	2%	0%

MEL = Minimum Equipment List
AOG = Aircraft On Ground
ETOPS = Extended Twin Engine Operations

Class C = Consumable
Class E = Expendable
Class ER = Expendable-Repairable
Class R = Repairable
Class T = Rotable

Source: Cathay Pacific (March 2008) "Materials System", Company Presentations

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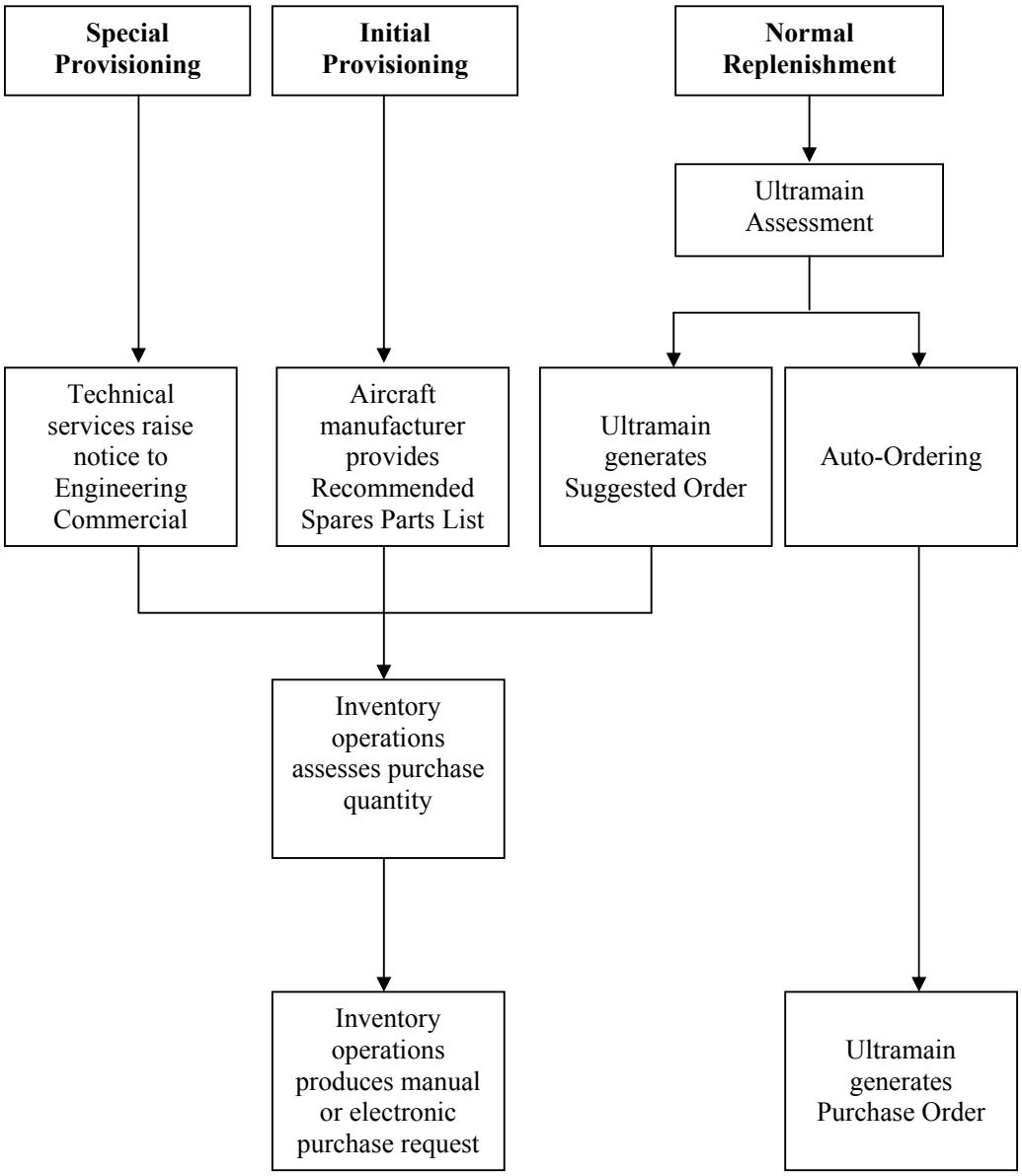
EXHIBIT 5: INVENTORY CONTROL PROCESS



Normal replenishment referred to the constant monitoring of parts and components usage. This process was kick-started by the generation of suggested orders from a module in Ultramain, a proprietary IT system used by Cathay Pacific, called Materials Management Reorder Process. Suggested orders were automatically generated when stock levels of any part had reached any of the three predefined criteria: re-order point, re-order quantity or safety level. This information would be sent to operations officers to decide on purchase decisions and purchase quantities. Subsequently, a buying request and an electronic purchase order would be issued. If the preferred supplier could not fulfill the order, the operations team would be informed and alternatives would be generated by the system.

Initial provisioning referred to the spare parts procurement process for newly acquired aircraft for maintenance purposes or parts required for initial modifications and follow-up adjustments. These purchase decisions and purchase quantities were based on previous operational experience, forecasts, and recommendations from aircraft or component manufacturers. These initial provisioning purchase orders were confirmed only after the anticipated order had been compared to Cathay Pacific's existing inventory database in order to ensure Cathay Pacific did not already hold a stockpile of these items. Once a purchase decision was made and the quantity determined, a Direct Requisition ("DR") was initiated in Ultramain. Upon approval, the DR was routed onward to the appropriate operations personnel for further processing.

Special provisioning was triggered when spare parts were required due to non-routine undertakings. These types of parts often had special requirements. For example, the marketing department might request an interior reconfiguration that involved cabin furnishings that complied with a certain level of flame resistance, which in turn needed to be communicated to the inventory operations department for consideration.

Source: Cathay Pacific (1 May 2006) "Engineering Procedure Manual Inventory Operations Volume 9A", Company Presentations, p. 6.

EXHIBIT 6: INFORMATION OF UTLRAMAIN

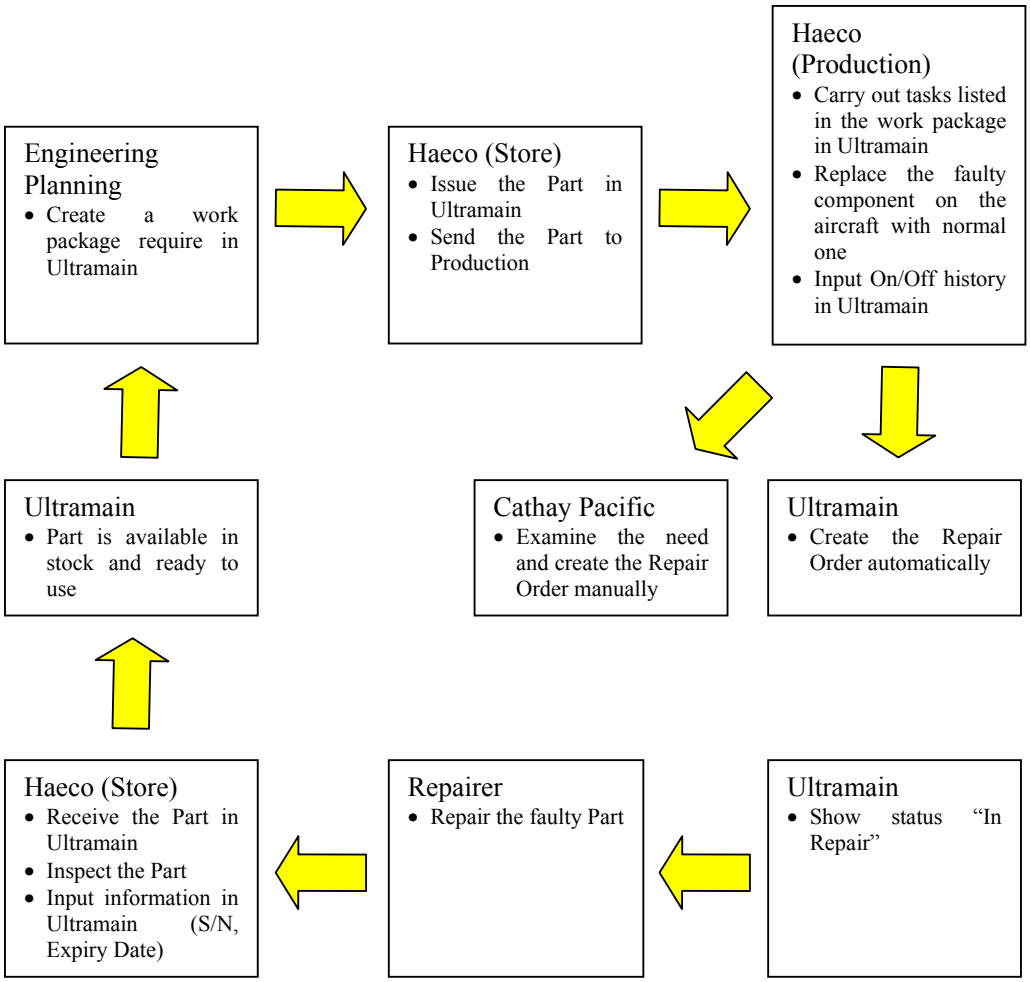
Ultramain was a third party mechanical and engineering (M & E) application Cathay Pacific acquired from a software company Ultramain Systems, Inc., which was located in New Mexico, USA. Ultramain was designed as a comprehensive maintenance and logistics solution for aviation, transit, and facilities industries since 1985. Ultramain had been further enriched to support aviation's M & E with the customizations made to meet Cathay Pacific's business needs since 2001. Ultramain was first launched to Cathay Pacific in Dec 2002 to support the inventory & logistic management. It was then launched to manage the technical log process and support the maintenance management afterwards.

Ultramain was an integrated system approved by Hong Kong Civil Aviation Department and was used by different sections in Cathay Pacific engineering department. Every staff had the responsibility to ensure the accuracy and the conformity of the data in Ultramain.
On technical side, it helped to update the aircraft configuration and the usage of various parts and components, forecast and plan the aircraft maintenance schedule, record the technical logs and cabin logs. Technical Services team made use of the information to analyze the performance of various systems and do the defect management. Engineering planning could also create the work packages for the aircraft to be inputted to hangers. The work packages included tasks close to expire, mandatory tasks and some ad-hoc tasks. Quality Assurance team would rely on the data to ensure that the aircraft meet the requirements of the civil aviation authorities including HKCAD, FAA or EASA.

For Inventory Operations, it helped to manage and administer the supply and stock level of all parts and components to support Base and Line aircraft requirement as well as the related logistics flow of parts to meet the needs of the aircraft either in Hong Kong or outstations. It recorded information such as ATA Chapter, P/N, S/N, Operational Qty, Re-order Point (ROP), Re-order Qty (ROQ), Bin Location, GRN, Keyword-Description, Shelf Life expiry date (if applicable) etc.

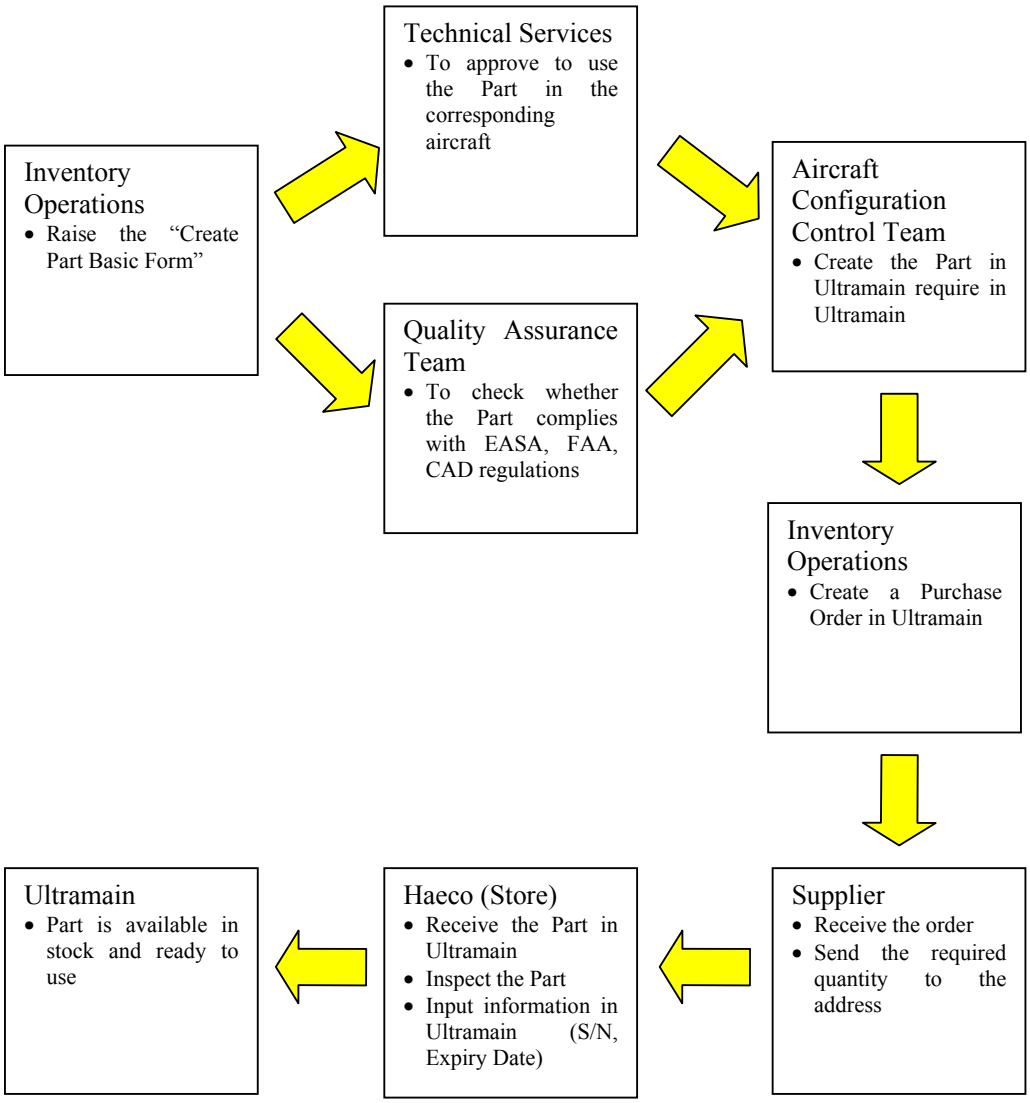
Source: Cathay Pacific (June, 2008)

EXHIBIT 7A: COMPONENT REPLACEMENT



Source: Cathay Pacific (June, 2008)

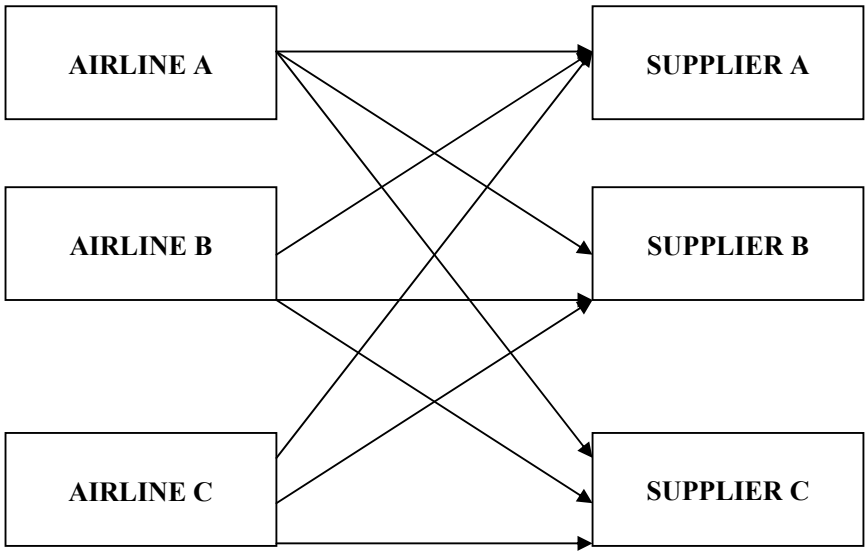
EXHIBIT 7B: CREATION OF A NEW PART



Source: Cathay Pacific (June, 2008)

EXHIBIT 8: BEFORE AND AFTER THE AEROXCHANGE SYSTEM

Before the Aeroxchange System:



After the Aeroxchange System: