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ON THE WAY TO CPFR FROM ARS

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Abstract: *Stores are becoming uncommon in the manufacturing or production areas. Production units are already shifted to Just in Time (JIT). In the area of production, which are planned after many researches and self and competitor's experience, we could shift the stores out of the production but mostly went to logistics providers. It means store location and control are shifted from factory premises to vendor locations. But the past decade witnessed that in India the vendor location stores are also getting diminished as the change of technology is enabling them to reduce their inventory level. It is welcoming situation whereas in major overhaul sections, repair sections, daily service section of the products are bound to keep the stores as per previous demands. There is an unhealthy situation that, spare parts, consumables, parts require mandatory changes are stored in high volume in the stores in order to facilitate overhauls and repairs done without any interruption and to avoid production hold up. It is challenging as the staff members give lesser important to downsize the stock. Presently all the stores in major overhaul areas are applying an automatic replenishment system commonly known as ARS, which facilitate with all spares and consumables available at floor site based on the principles of previous consumption and mandatory changes. The major component returns to overhaul floors of for repair require different types of parts. This can be ascertained only when the major product go for strip examination. Recovery and replenishment is based on the inspection only but in order to avoid production holdups, the stores procure the items in advance based on ARS principle. This paper is trying to enlighten about a new system which will be helping the overhaul units and base repair depots to reduce the stores.*

Keywords: *Automatic Replenishment System (ARS), Collaborate Planning Forecasting Replenishment (CPFR), Economic Order quantity (EOQ), FNSD – Fast Normal Slow and Dead moving, Manufacturing Resource Planning (MRP II).*

INTRODUCTION

Automatic Replenishment System (ARS) was introduced to have continuous flow of supply of raw material, semi-finished goods, consumables etc. in the production line without any interruption. Identification of item, the required quantities and intervals of supply for ARS was forecasted by analysing the previous consumptions but regularly amendment during the course of production and supply. Mostly fast moving items with low cost were included in the ARS but there are some slow moving items also find places in the ARS due to the definite requirement in regular intervals. High vigilance is warranted in ARS to avoid sudden breakdowns in the production line or surplus inventory as both are affecting company's exchequer. Due to globalization and advancement in technology ARS is giving way to Collaborate Planning Forecasting Replenishment (CPFR).

To have CPFR the company should have effective communication system stretching from the supplier to the distributor and customer. For the introduction of the CPRF the buffer-stock in each level i.e. Suppliers, Production line, semi-finished goods store, finished goods store, retailers etc. have to be assessed as per the expected sales and transportation lags. The communication system in B2B and B2C enables to pass information to all levels once customer demands an item at a time without any time delay. It means if there is a demand of finished product from the customer, the suppliers of the raw materials to the company will be supplying materials according to the demand placed by the customer for the finished goods without receiving any direction or demand from the company or from production line. Such an automated system has been developed so as to reduce inventory and established JIT. In the present business scenario the goods are produced not on the basis of past sales experience or forecast but on the actual demands placed by the customer.

REVIEW OF LITERATURE

Roberto Luis Hollmann, Luiz Felipe Scavarda, Antônio Márcio Tavares Thomé :There is no consensus regarding the breadth and scope of CPFR configurations. CPFR is context-dependent and varies according to the configuration of the SC. Trust, information-communication technology and the quality of information sharing are main enablers and inhibitors of implementation. Practical implications – Practitioners will benefit from insights related to the choice of SCC configurations (e.g. number of partners, nature of products and

spatial complexity), the importance of trust and empowerment for SCC and the need to outweigh carefully the costs and benefits of specific SCC before implementation[1].

Ireland, Ronald K. and Colleen Crum. "Supply Chain Collaboration: How to Implement CPFR and Other Best Collaborative Practices: Implementation procedures must be taken up case to case basis and it is necessary in modern business[2].

Tien-Hsiang Chang, A study of an augmented CPFR model for the 3C retail industry, To propose and test an augmented collaborative planning, forecasting, and replenishment (A-CPFR) model in a retailer-supplier context with a view to improving forecasting accuracy and then reducing the "bullwhip effect" in the supply chain. The description of the case includes: case company background; an "as-is" model analysis; a "to-be" (CPFR) model analysis; and a description of the results and potential benefits. The paper then proposes an A-CPFR model for the case and performs a simulation of the new model for comparison with the existing CPFR model. The results show that the mean absolute deviation of forecasting and the inventory variance are both better in the proposed model than in the existing CPFR model. The proposed model can thus improve the accuracy of sales forecasting, reduce inventory levels, and reduce the "bullwhip effect"[3].

According to Wilson(2010,p.59) Lean manufacturing is a manufacturing system that has a focus on quantity control to reduce cost by eliminating waste, is built on a strong foundation of process and product quality, is fully integrated, continually evolving and is perpetuated by a strong healthy culture that is managed consciously, continuously, and consistently. At the heart of lean, is its long-term philosophy of growth by generating value for the customer, society, and the economy with the objectives of reducing costs, improving delivery times, and improving quality through the total elimination of waste.

This is closely related to changes in the system of logistical targets, which now pursues an increase in company value as the supreme business target, through improving the availability of goods and materials, as well as reducing inventories (Vörös, 1999 and Weber/Dehler, 2000).

[1]International Journal of Productivity and Performance Management Emerald 2004ISSN: 1741-0401
[2] "Supply Chain Collaboration: How to Implement CPFR and Other Best Collaborative Practices."
By Malehorn, Jack | The Journal of Business Forecasting, Winter 2005
[3]Supply Chain Management: An International Journal, emerald ISSN: 1359-8546

Eswaramoorthi et al, (2011) discussed the current status of lean implementation in Indian machine tool industries as well as tinted some allied issues. The survey has attempted to formulate simple questionnaire based tool to identify the existing level of lean practices, reasons for inadequate priority to lean concepts, type of lean tools employed, perceived level of different wastes, and the common difficulties encountered by the Indian Machine tool Manufacturers. The survey results revealed that 31,6% of the companies have implemented different lean tools and techniques in selected areas. The remaining 68,4% of the companies have not yet taken up the lean initiatives.

Ajith Kumar Sahoo et al (2008) suggested a systematic approach for the implementation of lean principles and also describes an application of Value Stream Mapping (VSM). Consequently, the present and future states of value stream maps are constructed to improve the production process by identifying waste and its sources. Furthermore, Taguchi's method of design of experiments is pursued here to minimize the forging defects produced due to imperfect operating conditions. A noticeable reduction in set-up time and Work-in-Process (WIP) inventory level is substantiated. Nitin Upadhye et al, (2010) descried major actions taken by the company to implement lean philosophy to improve its efficiency and effectiveness. This study attempted to point out various wastages and issues to implement the lean manufacturing systems in MSME. It is observed that Lean Manufacturing Systems (LMS) helps to identify and minimize waste. Lean tools like kaizen, JIT, VSM, 5S, SQC, preventive maintenance, total employee involvement, and SMED were used to find and eliminate the wastages in a MSME

INVENTORY MANAGEMENT

CPFR is designed with inventory tools like Economic Order Quantity and Lead time analysis. The meaning of inventory is stock of goods or a list of goods. As per usage point of view inventory includes:-

- Tools:- includes fixtures, dies, patterns, gauges and hand tools used with machines and operations.
- Supplies:- these are the items such as abrasive, lubricants used to aid production but do not get into the product.
- Raw materials:- these are commodities such as steel, lumber, fabric etc. And purchased parts such as gears, pistons etc. That goes into the final product.

- Goods in process:- these are materials that have been partly fabricated but are not yet completed.
- Finished goods:- these are completed items ready for shipment.

The raw materials and the finished goods will come in and go out from the intermediateries of supply chain. Hence types of inventories can be, Raw material and supplies inventory, Finished product inventories, Maintenance repair and operation (MRO) inventories, In process inventories, Production inventories, Dealers stock, Material on transit, Anticipation inventories, Fluctuation inventories, Lot size inventories and Transportation inventories.

The main objectives of inventory management are operational and financial. The operational objectives mean that the materials and spares should be available in sufficient quantity so that the work is not disrupted for want of inventory. The financial objective mean that investment in inventories should not remain idle and minimum working capital should be locked in it.

ECONOMIC ORDER QUANTITY (EOQ).A decision about how much to order has great significance in inventory management. The quantity to be purchased should neither be small nor big because of buying and carrying cost of materials e very high.EOQ is the size of the lot to be purchased which is economically viable. The quantity of material which can be purchased at minimum cost.EOQ is the point at which inventory carrying cost are equal to order costs. In determining EOQ, it is assumed that costs of managing inventory is made up solely of two parts, i.e. Ordering cost and carrying costs.

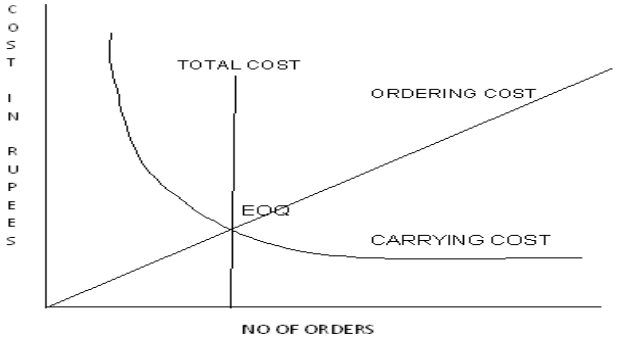
ORDERING COST. These are the costs which are associated with the purchasing or ordering of materials.

These costs include:-Costs of staff posted for ordering of goods. A purchase order is processed and then placed with suppliers the labour spent on this process is included in ordering costs. Expenses incurred on transportation of goods purchased. Inspection costs of incoming materials. When the items are purchased from outside then it will be known as buying cost. If the materials are manufactured in the same concern then these costs will be known as set-up costs. The ordering costs are totaled up for the year and then divided by the number of orders placed each year.

CARRYING COST. These are the costs for holding the inventories. These costs will not be incurred if inventories are not carried. These costs include:-The cost of capital invested in

the inventories, an interest will be paid on the amount of capital locked up in inventories. Costs of storage which could have been used for other purposes. Inspection costs of incoming materials. The loss of materials due to deterioration and obsolescence. Insurance cost. Cost of spoilage in handling of materials.

Ordering cost increase as the number of orders increases. Carrying cost decreases as the number of orders increases.EOQ is that quantity where the total cost is minimum.



EOQ ANALYSIS

If annual demand of an item is 10000, carrying cost is Rs.0.75 per unit and ordering cost is Rs. 150 then:

EOQ =Square root of (2X150X10000)/0.75 = **2000**

NUMBER OF ORDERS PER YEAR= DEMAND/ORDER SIZE

10000/2000 = 5 ORDERS

ANNUAL ORDERING COST = 150 X5 = 750/-

AVERAGE INVENTORY LEVEL = ORDER SIZE / 2

ANNUAL CARRYING COST = 0.75X2000/2 = 750/-

THE TOTAL INVENTORY COST= ORDERING COST + CARRYING COST

750+750 = Rs.**1500**/-

ORDER CYCLE = 12/5 = **73 DAYS**

RESEARCH METHODOLOGY

Repair and overhaul of helicopters happening in four major areas, Aircraft overhaul, aero engine overhaul, aircraft components overhaul, aero engine component overhaul and testing of aero engine. Participation observation method is adopted to find out the existing Automatic Replenishment System in aero engine production. Data also obtained from the production planning with regards to the number of production and from inspection team on number of rejection.

COLLECTION OF DATA

As the number of subassemblies and parts are numerous in number this study is undertaken on ARS system adopted in the sub assembly of air compressor. The scope this study is even though reduced to compressor and connected blades but it has got higher rate of rejection.

COMPARISON OF ARS AND CPFR

If JIT principle is applied in the repair and overhaul area of major components where the demand of items fluctuates, the organization may end up in over stock or under stock. To prevent under stock, the traditional organizations supply the goods in advance as per the previous data. This system is known as Automatic Replenishment System. In order to avoid surplus stock they were very vigilant on the previous data (the old orders), but still some items are held on the stores. ARS reviews were made by classifying the stores in Fast Moving, Normal Moving, Slow Moving and Dead Moving (FNSD). Still we found that even after many reviews we used to have many dead moving items. Having more stores in 'N', 'S' and 'D' category, increases the inventory carrying cost and blocking the working capitals.

ASSEMBLY LINE OF HELICOPTER ENGINE

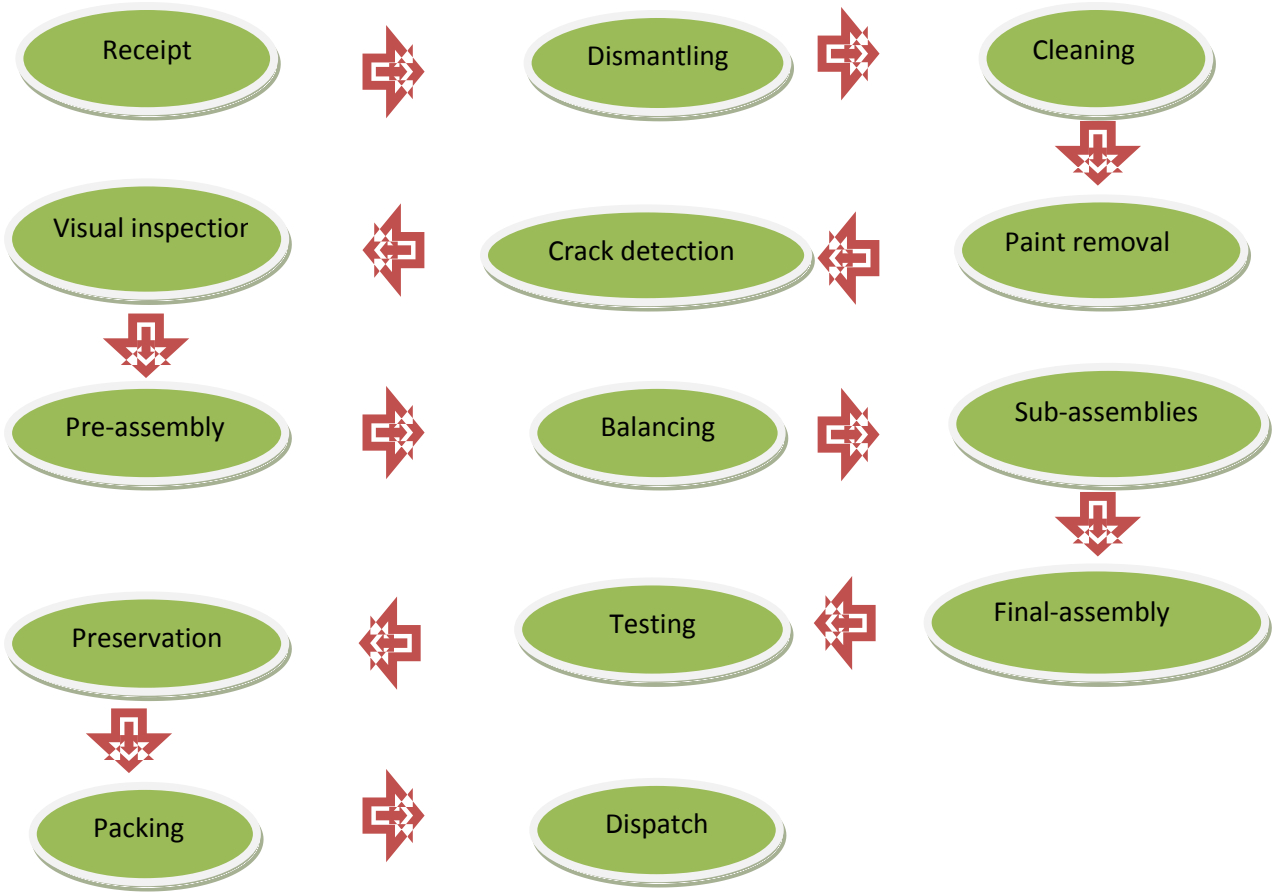
Turbo shaft engines are designed to deliver maximum torque to the main gear box to rotate the main and tail rotors and some amount is diverted to engine gearbox which houses all the accessories like starter motors, fuel and hydraulic pumps, oil pressure pumps and scavenges pumps. The engine has First Support which houses the front bearing of the compressor, 12 stage compressor, with static guide vanes, a second support to hold compressor end bearing and front turbine bearing, an annular combustion chamber followed by HP turbine and LP turbine with nozzle guide vanes. Due to operations in the area of saline weather or sandy conditions the compressor blade tips get eroded and especially the 10^{th}stage, 11^{th}stage and 12^{th} stage blades.

For example on every major overhaul the blades conditions are examined visually and measured with micrometric devices for recovery of existing one and the blades beyond the acceptable measurements are replaced with new blades. On the basis of previous demands the compressor blades are readily made available in the production line in order to avoid production hold ups without considering the quantity of the recovered blades.

Parts like turbine blades, nozzle guide vanes, combustion chambers etc. also will be inspected for acceptance or repair or for rejection. The major components will have some

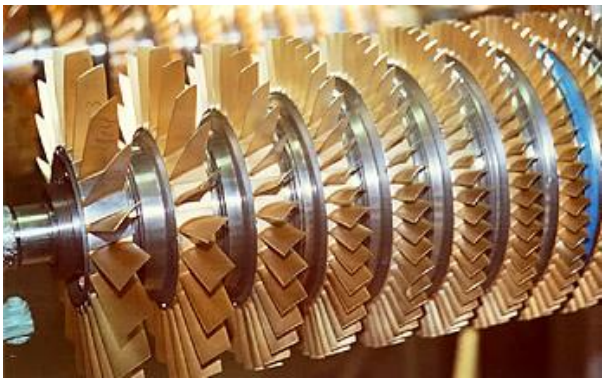
constant reviews in ARS system, whereas the small parts are ignored in the reviews as the rejection and consumptions are very high. The quantity and size is not the only measures for pricing the items, the material, the treatment given to that to withstand the temperature and pressure is also considered during pricing.

MOVEMENT OF PRODUCT DURING OVERHAUL



COMPRESSOR ASSEMBLY

12 stage axial flow compressor is used in the helicopter engine which is driven by single stage high pressure turbine. The free turbine is connected to main gear box which in turn rotate the main and tail rotors. The hot gas from the combustion chamber is directed to impulse reaction turbine blade by nozzle guide vanes. The hot gas from high pressure turbine is directed to the low pressure turbine by another set of nozzle guide vanes. The maximum power from the hot gases is derived by free turbine and it is used to rotate the main gear box. To have a better control over the helicopter the jet pipes are fixed in an angle so that resultant force of the trust from both the jet pipes of two engines will fall on the straight line.



Picture 1 - Compressor Assembly

A singe drum compressor houses twelve stages of blades which has got a compression pressure ratio of 8.95Kg/s. Erosion or chipping away of metals from the blade is the common reason for rejection. Erosions is the agreed form of corrosion as many helicopters and subjected to saline weather conditions. When the compressor performs its highest efficiency the strength of the material at that point will be very low. Any small particle including sand can chip of the metal portion from the blade.

Picture 1 - Eroded Compressor Blade

Table 1 - Rejection of compressor blades

Stage	Static	Rejection of **Static** Blade in %	Rotor	Mean rejection of **Rotor** blade	Number of overhauled engines Annual overhaul	Annual rejection for compressor **Rotor** blade
1.	60	-	37	1	14	14
2.	60	-	43	1	14	14
3.	60	-	59	1	14	14
4.	60	0.01%	67	2	14	28
5.	80	0.01%	73	10	14	140
6.	84	0.01%	81	20	14	280
7.	84	0.10%	89	40	14	560
8.	88	0.10%	89	50	14	700
9.	88	0.10%	89	70	14	980
10.	90	1%	89	89	14	1246
11.	90	1%	89	89	14	1246
12.	114	1%	89	89	14	1246

Table 2 Retrieval and Consumption of rotor blades

Stage	Rotor	Mean rejection of Rotor blade	Retrieval Made	Annual retrieval for compressor rotor blade	Annual Consumption for compressor rotor blade
1.	37	1	1	14	0
2.	43	1	1	14	0
3.	59	1	1	14	0
4.	67	2	1	14	14
5.	73	10	2	28	994
6.	81	20	5	70	1064
7.	89	40	6	84	1162
8.	89	50	6	84	1162
9.	89	70	2	28	1218
10.	89	89	0	0	1246
11.	89	89	0	0	1246
12.	89	89	0	0	1246

MAJOR FINDING AND SUGGESTIONS

Rejection rates of the blades at the final stages are much higher than the initial stages. As the helicopter engines are relatively free from foreign object entry as the engines are located in higher position, the saline weather or sandy weather can create corrosion and erosion to the blades especially when they deliver maximum power. With this assumptions automatic replenishment system procure 10^{th},11^{th} and 12^{th} stage blades to its maximum requirement with the expectation of 100% rejection. As the product are made available technicians may give less importance to retrieval of end stage blades as it require more inspection time due to small size.

IMPLEMENTATION OF CPFR

CPFR in the area of major overhaul and repair is challenging as the demand of parts fluctuate from product to product. Demand of consumables and mandate replacement items can be forecasted whereas rest must be supplied as and when required. In basic operation of major overhaul or repair maximum items are recovered from the existing product and components and parts other than that of mandatory changes which are declared Beyond Economical repair (BER) for further use during various types of inspections are obtained from the stores. It varies as per the area of operations of the major product.

For example the major product is subjected to saline weather conditions, desert conditions, humid conditions etc.

Uninterrupted supply by keeping the lowest mot inventory it the efficiency of Materials manager. The methodology of implantation of CPRF has certain prerequisites.

1. Codification of parts.
2. Collect the requirements at the time of receipt of the major component itself.
3. Plan the lead time according to the time required to complete the different functions in the overhaul.
4. Components which required replacement must be made available when major components reaches to sub-assembly and final assembly.

Inspection section should be capable for classifying the rejection into different categories. An integrated system should be established with the help of computer software to analyze the individual blades of each engine for its fitness for reuse. On examination of the blade the quality inspector should be able to assess the percentage of acceptability and must be recorded through a computer integrated programme.

On the basis of reject recorded in the computer integrated programme for each stage rotor or static blades the replenishment system should develop through the same ERP platform.

POSSIBLE OUTCOME ON IMPLEMENTATION OF CPRF IN PLACE OF ARS

An integrated team should work to analyze the material requirements on each major product from the time of acceptance of the major product for overhaul. This can be done through IT enabled job card and micrometry system. The micrometry system will initiate the procurement process even though it is not their objective. But such integrated movement can bring the accurate requirement of materials. An extended manufacturing requirement planning with necessary firewalls can be extended to the suppliers. This can be made applicable not only for the compressor rotor blades but also for all the parts.

ADVANTAGES

Frequent reviews and clerical errors are eliminated. Working on actual values and not on forecasted values, hence forecasting errors are avoided. Demand is automatically raised by the system when the values of the inspector do not match with the standards set. No overstocking or under stocking.

CONCLUSION

Collaborate Planning Forecasting Replenishment (CPFR) made many companies to shift from Material Requirement Planning (MRP) to Manufacturing Resource planning (MRP (II)) and to Just in Time (JIT). Whereas it is still a challenge in major overhaul sections and major repair division. Dynamic self-motivated team is highly essential in this are to have an integrated planning.

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