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Use of Supply Chain Management in Line Balancing to Reduce Cycle Times and Improve Productivity

Air Vice Marshal Chintaman S Sohoni*, Dr Ajit kumar Nigam, Dr. Sourabh Tiwari***& Air Cmde (Dr) Sanjay Kumar******

** Research Scholar, Center for Continuing Education, UPES, Dehradun*
*** Associate Professor, University of Petroleum and Energy Studies (UPES,) Dehradun*
**** Assistant Professor, UPES, Dehradun*
***** Indian Air Force (Industry)*

ABSTRACT:

After receipt of instructions to increase production of overhauled aircraft from 12 to 18 per year, a need arose to rebalance the production line so that an aircraft is produced every 20 days instead of every month. Many methods to balance the line again were studied, however due to a major constraint of manpower all the methods had to be rejected. The final solution could be achieved only after the supply chain managers were brought into the loop and supply of spares were managed that a final solution to the line balancing problem was found. A great combination of the planners and the suppliers had to be in place to solve the issue. The result was obvious, the defence department received their 18 overhauled aircraft per year as per the threat perception.

Keywords: *Supply chain management, line balancing, vendor development, productivity*

INTRODUCTION:

The defence aircraft overhaul factory was tuned to overhaul 12 fighter aircraft a year, however after a threat perception, it was planned to increase this to 18 aircraft per year. There were constraints of manpower, tools, testers and spares. There were many stages in the overhaul process and each was required to be analysed to reduce the total cycle time of overhaul production. Being a government organisation even money was a big constraint. The supply chain management and the production planning teams then went into overdrive to achieve this.

THE OVERHAUL SCHEME

The aircraft overhaul is carried out in stages as listed below:-

(a) Dismantling and Cleaning
(b) Defectation of Airframe
(c) Defectation of Electric fittings
(d) Repair of Airframe
(e) Repair of Electrics
(f) Sub-assembly
(g) Final Assembly
(h) Testing and certification

Line balancing is an effective tool to improve the throughput of assembly line by reducing non value-added activities, and thus cycle time. (Amardeep, Rangaswamy, & Gautham, 2013)The main aim of the Line Balance is to distribute the total workload on the assembly line as evenly as possible, despite the reality in which it is impossible to obtain a perfect line balance among the workers. It is then the role of line balance efficiency which is related to the differences in minimum rational work element time and the precedence constraints between the elements. (Hamza & Jassim, 2013) For production of 12 aircraft per year, in the present case, each of these stages was balanced for one month, thus producing 12 aircraft per year.

THE PROBLEM

When the requirement of producing 18 aircraft was given, the production planning department had to work out a plan so that each stage was completed in 19-20 days, instead of 30 days earlier, so that 18 aircraft could be produced in a year. As already stated, this involved planning for additional manpower, tools and spares. This problem was tackled jointly by the Supply Chain and the production planning department, initially separately and later jointly, for each stage of overhaul. The steps taken for this are enumerated in subsequent paragraphs.

LITERATURE REVIEW

A thorough literature review was carried out to find line balancing solutions so that the requirements of the defence department were met. Most of them however had to be rejected as being not feasible, since there were severe constraints of manpower and funds. This was mainly due to the fact that no additional manpower was forthcoming, specially not to the tune of 50% to achieve the task. It was thus here that the supply chain managers were given the additional task to help manage the line through quicker and larger procurements.

THE SOLUTION

It was realised that an out of the box thinking and a non-conformist solution was required to get an answer to the problem of line balancing. While there are standard methods of line balancing available, it was decided to achieve this mainly through Supply Chain Management. The solution for each stage of overhaul was then considered separately, which is discussed in subsequent paragraphs.

Dismantling and Cleaning

After study of the dismantling process, it was revealed to the planning section that nearly 1000 nuts and bolts are removed and are sent to refurbishment. The nuts and bolts were counted at the time of removal and the number of nuts and bolts which were rejected during this process were marked separately. The Supply chain department then ordered manufacture of these for the quantity rejected. After the cleaning process some more nuts and bolts (called simply bolts hereafter) were generally found unusable and a second order was placed for the same. It was found that more than two days were lost by this double accounting and ordering process. It was also established that a further two days could be saved by improving the dismantling process. Additional two days were saved by improving the cleaning process.

A study of historical data of rejected bolts revealed that about 15% of these were getting rejected in every overhaul. Thus, after establishing that 2.7 sets (18 X 15%) of bolts will be required in the year, it was decided to order three complete sets of bolts ab initio. This had twofold benefits. Firstly, ordering higher quantities reduced costs of procurement, and it also enabled establishing more vendors, build up competition and improve quality. Secondly, the manhour saved due to reduction in accounting was diverted to the cleaning process. With augmentation of only two more workers and active contribution by the Supply chain department, it was possible to reduce the whole process of dismantling and cleaning by ten days.

Defectation

Defectation is a process of finding defects in the Airframe structure and the electrical system which might have developed during exploitation of the aircraft. The airframe team was tuned to do their work in a month's time. This was followed by the electrical team for another month. The planning department found that it was possible for both teams to work together by taking one side each of the aircraft. Thus the airframe team worked for 20 days on the port side of the aircraft, and the electrical team worked simultaneously on the starboard side. The teams changed sides and completed their tasks in another 20 days. Since the teams worked on only half the aircraft at a time, manpower management was easier. Thus each team got 40 days each to work but completed the defectation process by taking much less time than the 60 days taken earlier. The manpower and the tools were more effectively used to form two teams with a minor augmentation of manpower. Since defects were reported early, the supply chain team also had more time to procure required spares, thus improving overall efficiency of the process. In fact after realising from study of old data that about 20% of electrical cables were replaced during each overhaul and approximately one sheet of aircraft material was used up during each repair, 4 sets (18 X 0.2 = 3.6 say 4) of electrical cable and 20 sheets of aircraft metal were ordered with staggered supply so that there were no delays in the repair stage. The formation of two teams also ensured that a line balance of 20 days was achieved.

Repair

The repair process was also improved similarly by time and area sharing and the repairs were also completed in 40 days instead of 60 days, thanks to the efficiency of the Supply Chain group which procured the spares in advance enabling the system to achieve the required line balance. With little augmentation of manpower and internal manpower adjustments, two teams could be formed thus maintaining a line balance of 20 days, with each of the airframe repair team, and the electrical repair team taking 20 days each for their repairs. So as expected both the stages got balanced together.

Sub-Assembly

During sub-assembly stage all the components, instruments etc are fitted back after receipt from component repair shop. A major challenge was faced here since the component repair shop also needed to repair / overhaul the components and instruments early so that these are available to the aircraft repair line in time for the sub-assembly stage. Once again the Supply Chain group played a major role here. This is explained in the subsequent paragraph.

The supply chain group is also responsible for procuring spares against unserviceabillitiesin field units. While new components are procured against these requirements, the field units generally require components with life enough only till the next overhaul. It was therefore decided to trace components received with partial life on the aircraft received for overhaul. All such items were allocated to units after a simple functional test and the new items which were received were diverted for use on the sub-assembly stage. This enabled reduction of cycle time for production of components for overhaul. Also since there was a saving in manhours due to use of new components rather than doing a complete overhaul of components, no additional manpower was required in this stage of overhaul. The supply chain thus played a very important part in reducing the stage time to 20 days and maintaining the new production schedule.

Final Assembly, Testing and Certification

Many teams, viz, Airframe, Engine, Electrics, Instruments, Radar etc worked one after another for the final assembly which was balanced for 30 days earlier. The planning team found that by employing flexi-timing and shifts the task can be completed in lesser time. By this method thus, the time taken for these two stages was reduced to 20 days each and total line balancing to produce 18 aircraft per year was achieved.

CONCLUSION

Line Balancing (LB) is a classic, well-researched Operations Research (OR) optimization problem of significant industrial importance which was effectively used in solving this problem in an unorthodox manner.

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