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Manufacturing Cycle Cost reduction of Components thrusts business growth for aerospace Industries

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***Abstract* - Reduction in manufacturing cycle cost of critical components propels opportunities of business in aerospace industries and its sustainability and emerging economies. Defense sector Indian budget takes generally minimum 1.5 to 2% of GDP. India's defense budget approximately around 2% of GDP in 2020-21, means around 4.5 lakhs crores. Air force allocates around 75 thousand crores for aircraft and helicopter's development, innovation and modernization annually. Major portion of budget goes for critical component's purchasing of aircraft, helicopter, missiles etc. It is therefore focused to reduce manufacturing cost of components of aviation, aerospace and aeronautical field. Hence reduction in manufacturing cost in any field creates a revenue generation in our economies.**

At low cost manufacturing generate more production of aerospace components which will propel more and more work in aviation and aerospace manufacturing and more engagement of material & man power surges the revenue generation. Likewise there will be a high thrust in business for aerospace manufacturing field and their product as aircraft, helicopters, satellite, rockets, and space shuttle etc. By using Industry 4.0 that is fusion of technology which will establish a high-tech business in aviation field. Aerospace manufacturing, aeronautical manufacturing leads towards business of helicopters, aircraft military, aircraft civil, rocket and satellites etc. Industry 4.0 nurtures the future model of business by applying robotics automation by artificial intelligence, simulation, augmented reality, horizontal and vertical system integration, additive manufacturing or 3-D printing, IOT or IIOT, cloud computing, cyber security. By application of these pillar of Industry 4.0, manufacturing in aviation field will scale up and after that manufacturing time will reduce, business in aviation field will increase exponentially by keeping quality high in less time elapsed, during manufacturing of components of aviation field. To sustain in business, any organization need to go for modernization of their system by industry4.0. Industry 4.0 leads with high revenue generation and growth in business of helicopters, aircrafts, ships, aerospace satellite, rockets etc.

***Index Terms* - Manufacturing cycle time, Manufacturing Cycle cost reduction, Manufacturing time.**

INTRODUCTION

Manufacturing cycle time reduction is a very much challenging task for especially aviation and aerospace manufacturing organization due to have a confluence of many factors, complex interaction of operations and time involved in operations. If different operations time is reduced, labour time will be reduced and delivery time will be marginally influenced and reduced. Thus reduction of time in operations will lead reduction in delivery of helicopters or aircraft to customers. Some basic principles and approaches are applied to reduce manufacturing time. A conceptual work is applied which influence the factor of reducing the operational time in manufacturing of aviation components which are mostly long cycle components. This research will give a direction and guidance to industrial practitioner as to how reduce the manufacturing time by calculating and evaluating the value of operation of machine or process or inspection or movement or queuing etc in term of numerical value of time study in manufacturing of critical components of aircraft and helicopter.

Manufacturing cycle cost is based on a time elapsed for a raw material or sub-assembly to move through manufacturing processes. Cycle time consists of set up time, machine processing time, quality inspection time, transportation or move time and waiting time for loading in another machine etc. Process time is the time period required during the work is performed on the product itself. Inspection time is the time during which the quality of the product is confirmed. Transportation or move time is the time duration in which materials or works-in-progress (WIP) are moved from one workstation to another workstation.

Queue time is the time during which the product awaits to load in machine or transfer to a workstation, undergoes further inspection and succeeding manufacturing processes. Manufacturing time consists of time elapsed in, from loading of raw material on machine to finish the product. To manufacture a component, many factors are involved. We are more concerned in manufacturing cost reduction through optimizing the manufacturing processing time, movement time, inspection time, cell formation etc for helicopter or aviation components manufacturing. If operations time is being controlled without affecting the quality, then upto some extent we can reduce the time and cost during manufacturing. Industry 4.0 referred to Germany's attempts to integrate digital technologies into its national manufacturing strategy. Manufacturing possibilities will be multiplied by emerging technology breakthroughs in fields such as artificial intelligence, robotics, the Internet of Things, autonomous vehicles, 3-D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing. They collect huge amounts of data from smart sensors through cloud computing and IIoT platforms that allow them to uncover patterns that help them improve the efficiency of supply chain management and manufacturing production by time reduction. The application of Industry4.0 and lean have changed the world in manufacturing in field of aerospace and aviation products as helicopters, fighter jet, ships, rockets etc and their emerging global business.

RATIONAL OF STUDY

At present scenario, the operational cycle time for manufacturing of critical components of aviation asset as a helicopter or aircraft is very important. Critical components are defined as the components which are installed for functioning in different critical stage of helicopter or aircraft assembly under following conditions and environments. Critical components are long cycle items; it takes more time to manufacture than other components.

The components which are critical because they are functioned in different kind of environments and different working conditions. The aviation flying machine as a helicopter or aircraft may fly under different type of climate & environment. The components of aviation asset may have to function under different working conditions as High humidity, High temperature, High pressure, High Tensile load/force, High compressive load/force, High torque & high torsion, High stress, High strain, High centrifugal stress & centrifugal strain, Moment, momentum & Angular momentum etc. Critical components significance is much higher than other components with respect to functional sustainability and bear ability. More than 50% of total time of any aviation machine is concentrated in manufacturing of critical and long cycle components, these are very high in weight and huge in volume and big in dimension/ size. Thus operational cycle time is directly involved as a ingredient factor in term of time elapsed for aviation flying machine. The components are working under high tension, compression and rotary dynamics condition. We will see the proportion of critical components operations. Static critical and dynamic critical components are around 5% in helicopter and aircraft but these are long cycle items and around 40-50% time it takes as manufacturing of entire helicopter and aircraft. If manufacturing time reduction takes place in critical components manufacturing, it will have a significant or huge time reduction in entire helicopter and aircraft manufacturing. We will see all activities and its time elapsed for critical components as to how way their manufacturing throughput time is reduced.

LITERATURE REVIEW

The previous some researchers are mentioned who have done a lot of work on manufacturing time, manufacturing cycle time, throughput time reduction, lead time reduction, cycle time reduction in manufacturing field.

For reducing Manufacturing Throughput time, a framework was established by Danny J. Johnson, 2003 [1]. The framework is detailed to provide a direction and guidance to manufacturers to reduce throughput time. A flexible manufacturing system (FMS) consists of a set of workstations, capable of performing a number of different operations, interconnected by a transportation mechanism, (Joseph G. Kimemia, 1983 [2]. The waiting time is referred sometimes as waiting in batch and waiting for next batch respectively by Hopp and Spearman, 2001[3]. Variability often come in arrival of material and process of manufacturing which can be either controllable or random variation by Hopp and Spearman 2001[3]. The setup time of machine, processing time on part, and move time of material or work in progress are independent of each other (i.e., a reduction in move time does not affect setup time or processing time per part, and so on), changes in any of these components of times, can affect the waiting time by Hyer and Wemmerlöv 2002 [4 & 5]. Waiting time is usually the largest of the four components, accounting for as much as 90% of manufacturing lead time in some systems by Houtzeel 1982 [6]. In Setup Time Reduction, the dedication of Workstation and family scheduling can also reduce the number of setup and its setup time of machines. Further information on improving setup procedures can be found in works by (Steudel and Desruelle, 1992 and Shingo, 1985 [7]. In Arrival variability, when workstation's machine utilization is low and machine with operator is idle, then a substantial portion of the time and each job arriving to the workstation, finding the station is idle. In this case, variability in the time between arrivals of jobs tends to directly impact on output as variability in departure from machines. Then departure variability is reduced as by increasing the number of identical resource at the workstation by Hopp and Spearman, 2001 [8]. This framework provides an easy tool to industrial practitioner; they can use to determine a course of action to reduce manufacturing throughput time per part in their own plants by Danny J. Johnson, 2003 [1]. A Case Study is done on Reducing the Lead Time and Increasing Throughput by using Value Stream Mapping by Gokulraju et al., 2016 [9]. Lean Manufacturing, also called Lean Production, it is a set of tools and methodologies that aims for the continuous elimination of all waste in the production process. The main benefits of lean manufacturing are lower production costs; increased output and shorter production lead times by Gokulraju et al., 2016 [9]. Batch production and departmentalized machines are key contributors to long lead times. Value stream mapping is used to help identify areas of potential improvement to reduce lead times and increase their output or throughput. It was used to construct a current state value stream map by Gokulraju et al., 2016 [9]. The value stream is defined as the specific activities with a supply chain required to design order and provide a specific product or value by Hines and Taylor, 2000 [10]. Value Stream mapping of Rubber Products manufacturers by Jeffery, 1998 [11]. Redesign the value added chain of a service process in a commercialization steel firm at Monterrey, Mexico (Juran, 1999) [12]. By applying 5s, waste can be reduced. Waste could be in the form of scrap, defects, excess raw material unneeded items, old broken tools, and obsolete jigs and fixtures by Monden, 2012 [13]. Seiri: To make a move the items, tossing it to do away needless items, it will make material flow consistently or smoothly, and where workers & work move easily (Feld, (2000). Seiton: This will make it the right place and will make tools, jigs, fixtures and resources noticeable, detectable, and it may be easy to use (Feld, (2000). Seiso: A well maintained workplace can create a healthy environment to work there (Feld, 2000). Seiketsu: A regular observation, audit or check should be arranged to do and scoring should be assigned to everyone, as responsibility to maintain a high standard of housekeeping and cleaning Feld, (2000). Shitsuke: Management should do gemba as a walk to shop floor and explain what they want from people, reward those who follow the 5s and instruct strictly those who don't follow (Feld, 2000). Review on Cycle Time Reduction in Manufacturing Industries by Hiten Patel & Sanjay C. Shah, 2014 [14]. Manufacturing Organizations faces a challenge in reduction of cost and efficiency in their manufacturing Operations. How to Cut Manufacturing Throughput Time by Xenophon A. Koufteros , The University of Texas [15]. Manufacturing firms are facing an environment where success depends on quick response to customer demands, as time-based manufacturing practices which can reduce throughput time. Time-based manufacturing is defined in terms of organizational-level practices that reduce throughput time by Koufteros, Vonderembse, and Doll, 1997 [15]. The implementation of manufacturing cells for manufacturing of their part family by Wemmerlov and Hyer, 1989 [4 &5]. The establishment of quality improvement efforts during manufacturing sector are delineated by Juran, 1999 [12]. The initiation of effective preventative maintenance programs can be implemented for machines availability by Schonberger, 1996 [17], and these are viewed to make available the resources for manufacturing. The abilities to develop a base of the time reduction is dependable on suppliers of accessories and associated details and to achieve pull production system as customer demand or internal user demands by (Monden, 1983 [13] and these are also enhanced by shop-floor involvement. A Throughput Time Study on Gemba through ABC Analysis for High Demand

Product among Varieties of Products (Raj Mohan R & V.Senthil Kumar, 2013) [18]. Reductions in manufacturing throughput time increases flexibility and respond to customer orders supply on time by Raj Mohan R & V.Senthil Kumar, 2013 [18]. Time to be measured as per operation or activities where machine and man are working, Taylor, 1985 [19]. “Industry 4.0 is the fusion of these technologies [AI, big data, IoT, bioinformatics] and their interaction across the physical, digital, and biological domains that make the Fourth Industrial Revolution fundamentally different from previous revolutions — diffusing faster and more broadly than any of the previous revolutions”, World Economic Forum Klaus Schwab.[20].Managerial excellence in cost reduction and corporate performance are the basic tasks by strategical management and organisational development, Gopal krishnan, P. P. (1992),[21].Cost reduction by work study, method study,time study, bottlenecks of work study and work sampling or activities sampling are used in textile industries where similar machines, similar works on similar tasks are employed, Gopalakrishnan, P. P. (1992),[21].The focus of the approach is on cost reduction through eliminating non value added activities via applying a management philosophy. All these efforts is used to keep cost down and stay ahead in the race of competition. Rahani AR, M. a.-A. (2012),[21].Today global competitive environment has enforced manufacturing practitioners to deliver low-cost, high-quality products. Ghodsi, R. (2012),[22].Costing the value stream through lean manufacturing, Patrix, J. L. (2013)[23]. Overall Equipment Effectiveness is used as the measure of success of TPM implementation. The losses associated with equipment effectiveness are identified. All the pillars of TPM are implemented in a phased manner eliminating the losses and thus improving the utilization of CNC machines. Singh, R. (2013),[24].Global market and increased competitiveness have driven companies to seek methods and tools that make them more competitive and have forced the manufacturing systems to able to react to demand changes. In general, it is necessary somehow to improve the production system through the reduction of time and costs. Helleno, A. L. (2015),[25].Kanban and value stream mapping analysis in lean manufacturing philosophy via simulation of a plastic fabrication for case study Sabaghi, M. (2015),[26].Every organization faces the problem of allocation of resources. The resources include men, machine, material, and capital, Salma Shaheen, T. A. (2015),[27].This review aims to provide an overview to the extensive field of cost estimation for aerospace composite production, describing the basic methods of how to perform cost estimation and introducing some of the existing models. Review of cost estimation through methods and models for aerospace composite manufacturing is embedded with several strength, Ch. Hueber, K. H. (2016),[28].Aviation capital assets are characterized by huge Capital, long pay-off period, deep technology and maintenance intensive over their life cycle. Capital Investment Strategies for Target Revenue Generation under Performance Based Contracting for Aviation Assets through use of evolutionary algorithms, Vagrecha., G. S. (2016), [29].The reliability-cost trade off function envisages a particular value of reliability beyond which investment in reliability will increase the total life cycle cost of the equipment. Revenue generation for the customer is a direct function of reliability. Hence, an alternative approach to investment appraisal that seeks to maximize performance of the assets while optimizing life cycle costs needs to be evolved. Vagrecha., G. S. (2016), [29]. Cell Formation (CF) is an important problem in today’s automated batch type production systems. It reduces material handling cost, processing time, labor requirement, in-process inventories, number of set-ups, simplifies process plan, and increases quality of product. Optimum cell formation can lead to more independent cells and less intercellular movement of parts. Laha, M. H. (2016)[30].The matlab simulation software is used to check the values of lead time, inventory and total distance travelled within the range. The results show that there is a significant improvement in floor space, reduction in inventory, reduced lead time and distance travelled, . S. Mahendran1, D. A. (2016),[31]. The most Rapid prototyping (RP) technologies principle of creating three-dimensional geometries directly from computer aided design (CAD) parts are used for prototyping or tooling purposes but in future the majority may be produced as end-use products. The term ‘rapid manufacturing’ in this context uses RP technologies as processes for the production of end-use products. Dickens, N. H. (2017),[32].Value Stream Mapping (VSM) is employed for the analysis of manufacturing processes. The VSM analysis leads to improve the process through the reduction of non-value-added steps. The optimization is often verified by computer simulation (CS) before actual implementation in the factory. The two approaches imply in a different underlying way as a deterministic flow of material against a conceptual model of production stochastic queuing network. Dario Antelli, D. S. (2017), [33]. As design, materials, and manufacturing processes have to be considered integrative, it is pointed out which issues arise in the production of load adapted designs and using high strength materials. Frame and shell structure concepts as well as their related forming processes are presented. Finally, fields of further research are identified. M. Kleiner, M. G. (2017), [34]. Line balancing is the process of assigning tasks to different workstations, so that all the workstations have approximately equal time requirements. We used the method of line balancing to-minimize idle time-balance bottlenecks. Based on the current line balancing layout, the new layout was proposed with some of the processes. R. Suganthini Rekha, P. P. (2017),[35]. Product, operation, and route flexibility, as well as the starting-up and development flexibility assurance methods are described. The manufacturing systems classification based on the combination of different flexibility forms and its level is provided. Kapitanov, A. (2017),[36]. Lean manufacturing is an optimum approach for the reduction and elimination of waste within an organization. The case study company is based in South Africa and produces heat exchangers through main processes which include pre-assembly, core building, brazing and final assembly. K.P. Lusiba, M. D. (2018),[37]. Lean Manufacturing tool, integrated with small Kaizen activities to achieve methodically fostered process improvements. Overall Equipment Effectiveness and production cost are taken as performance metrics to evaluate the process improvements hence the significance of VSM. Abdul-Kader, S. Z. (2018),[38]. Value Stream Mapping (VSM) is a widely known lean tool to improve manufacturing systems. To eliminate these weaknesses and to further increase flexibility, we developed a dynamic value stream management concept taking both the recent digitalization technologies and organizational structures into account. Lugert, A. (2018),[39].Waste identification research was focused on elaboration of Transportation Visual Map starting with main activities such as: shipment loading, transporting goods to destination, unloading processes, and transportation back to the base and handling the paperwork. MOVE Measure was the new metrics that determined the transportation efficiency in terms of availability, performance and quality, all the factors being expressed in percentage. Cornelia, M. (2018),[40].Lean is the tool to reduce the wastage in all process of apparel manufacturing, reducing cost and value added to the product. This paper proposes the lean tool for the apparel industry to reduce the overall wastage of the industries. Mothilal, P. (2018),[41]. VSM has proved effective in identifying and eliminating waste in a facility with identical product routings such as in assembly facilities. During this process, the process-control in a well maintained, ordered, and clean operational setting which incorporates principles of just-in-time, employee-involved and continual improvement are highly required. D.Aravind, R. M. (2018),[42]. In this research, lean manufacturing aims to identify and eliminate waste so that the company could improve its performance in winning the industry competition. Lean manufacturing is a systematic approach used to identify and eliminate waste. This lean concept could improve responsiveness through waste reduction, continuous improvement and cost reduction. Zahrotun Nihlah, T. I. (2018),[43]. The scope of study is focused only on the VSM, which produces the map of operating state of the composite repair process. This map is used to identify sources of waste and identify other possible lean tools that may be suitable for reducing wastes in workshop processes. Fadzil Adly Ishak, M. K. (2018),[44]. The main objective of this research paper is to provide a road map for investigating the opportunities to reduce cost and improve productivity and quality in the existing production system through the application of Lean-Kaizen concept using value stream mapping (VSM) tool at shop floor of an Indian Small-Scale Enterprise (SSE). SunilKumar, A. K. (2018),[45]. The idle and delay time in an industry is categorized as production waste that will cause problems such as production quantity below the target. In addition, the waste also leads to cost losses and eliminate opportunities for the industry to gain profit. The need of waste analysis to optimize the costs incurred due to the idle and delay time. Lean manufacturing approach can be used to minimize that production waste. S Indrawati, A. A. (2019),[46]. Line balancing was done to improve the cycle efficiency by reducing the no of workstations and thereby decreasing the manpower required. Incorporating the improvements in the future state value stream mapping total cycle time could be reduced considerably and thereby the process could be improved. Sreekumar. (2019),[47].The role of Industry 4.0 technologies on the relationship between lean production (LP) and operational performance improvement within Brazil, a developing economy context. LP practices help in the installation of organizational habits and mindsets that favor systemic process improvements, supporting the design and control of manufacturers' operations management towards the fourth industrial revolution era. Tortorella, G. L. (2019),[48].The applications of Additive Manufacturing (AM) have been grown up rapidly in various industries in the past few decades. Among them, aerospace has been attracted more attention due to heavy investment of the principal aviation companies for developing the AM industrial applications. Annamaria Gisarioa, M. K. (2019),[49]. In the analysis, the manufacturing data of the finished products assembly shop of a radio-electronic enterprise is used. According to the results of use the proposed method, the duration of the assembly process was significantly reduced, which makes it possible to equalize the load of work centers and to reduce the volume of unfinished production. P A Russkikh, N. N. (2019),[50].

Value stream mapping (VSM) visually depicts the flow of materials and information as a product passes through the manufacturing process; this information enables companies to meet customer demand by getting these materials and information for improvement at the right place and at the right time. This author reviews the concepts and techniques of line balancing and demonstrates through empirical study how the concepts and techniques of line balancing can help optimize VSM implementation to enhance business performance. Cheng, J. L. (2020),[51].The present Gas Packaging and Process (GPP) line is unable to cope up with the increased demand due to its so many losses like more non-value-added time, old method related to material handling, improper material flow, less space and flexibility, more distance travelled by a worker in assembling station and bad ergonomics etc. Sanket Borgave, S. S. (2020),[52]. VSM is functioning as a tool for partial optimization, attempting to identify and resolve bottlenecks in individual functions and divisions, primarily in production activities. The original essence of lean production and flow management, promoting overall optimization by focusing on the flows across the value chain, and potentially leading to poorer performance in the overall value flows up to the customer. FUKUZAWA, M. (2020),[53].For improvement proposals are prioritized for the type of waste with the highest rating weighting, namely defects. This shows that the defect is the type of waste that most influences the production process, making it easier to explore the cause of the problem and the advice that will be given to reduce the defects that occur. Julian Robecca, I. M. (2020),[54].Lean Manufacturing (LM) has traditionally helped industries in removing the non-value-added processes to achieve operational excellence. Similarly, the blue ocean strategy helps organizations in creating an uncontested market space where the competition is irrelevant. Sadiq, S. (2020),[55].The objective of this study is to implement Lean manufacturing tools, in order to improve the production process carried out within a manufacturing company, with a small manufacturing batch. Based on real data from the manufacturing process, the current value stream mapping (VSM) was built, identifying both operational and non-operational times. After waste identification, an optimal solution was chosen for the manufactured parts required by the customer. Implementing the best solution resulted in a productive efficiency increase by 90.93%, which significantly reduces the manufacturing time. I C Gherghea, D. C. (2020), [56].

GAP-1- Sum of all involved activities and operations time and their evaluated respective cost are not considered by authors in available and published literature review. So this is also a gap and has been addressed in my research.

GAP-2- There are not much literatures focusing on time –cost conversion in aviation and aerospace critical components manufacturing in available and published literature till yet. This is for conversion of time for activities and operations in manufacturing system into cost of operation from raw material loading on machine to finished product.

GAP-3-The critical components and their manufacturing process are considered for manufacturing analysis in aviation, aerospace and helicopters industries.

All the gaps have been addressed and included in objectives and have been satisfied by data collection, their data analysis, data interpretation & prediction and found their result as well as inferences. We have interrelated my research field and direction to find time reduction and cost reduction of critical components in aerospace, aviation and helicopter manufacturing field. Here we are trying to approach an analytical study to calculate the value of operations and activities into cost and to show the reduction in manufacturing cycle cost by proposed and new manufacturing systems in comparison to old conventional and existing manufacturing system in aviation/aerospace/helicopter industries.

RESEARCH OBJECTIVE

1) Analysis of manufacturing cycle cost one operation.
2) Analysis of manufacturing throughput cycle cost all operations.
3) Analysis of manufacturing cycle time to manufacture the components.
4) Analysis of queuing time and queuing cost.
5) Analysis of processing time and processing cost.
6) Analysis of inspection time and inspection cost.
7) Analysis of move or transportation time and transportation cost.
8) Analysis of modernization of aviation machine shop with appropriate and suitable high version machines.

RESEARCH METHODOLOGY/ DATA COLLECTION/ PROPOSED TOOL AND ANALYSIS

Data collected for critical components of aircraft and helicopter of ABC aviation industry and apply different approaches /methodologies towards objective of research.

Approaches/Tool/ Methodologies:

- Toyota production system
- Lean Manufacturing concept (5'S & 8-Waste)
- GT-Group Technology
- U-cell formation
- CAD/CAM application
- Industry4.0 (cloud computing, additive manufacturing or 3D printing, IIOT etc)

Nonvalue added operations typically accounts for 90% of total manufacturing cycle time and it leads to lead time as higher and higher. We need to study the value-added activities and non-value-added activities and to reduce time for non-value added activities.

Two types of activities of operator on machines are involved

a) Internal activity: Activity on machine. Mounting/removing job/ tools from machine.
b) External activity: Activities outside the machine. Drawing, IS, bringing tool, material etc

1. Internal Activity (Activity on machine)
   - Set the operation programming.
   - Machine setting -Tool, die & fixture setting.
   - Starting the machine.
   - Holding the job/apparatus/switch/ machine handle etc.
2. External Activity (Activity outside the machine)
   - Bringing the tools.
   - Bringing the raw material
   - Searching the material / tools / gauge / dial-indicator/ clothes/ waste clothes

All the external activities are down time / idle time/ waste / non – value added activities. It may be somewhat minimized or it may be fully /partially eliminated by using modern and latest technology having machines e.g.:

a) F.M.S—Flexible machining system.
b) 3-Axis, 4-Axis, 5- axis CNC machine for a lot more operations at a time.
c) Instead of conventional lath, CNC (computerized numerical control) lath, NC (Numerical control) lath should be used.

List down the non-value-added activities / idle time of each component.

- Delay in collecting the raw material from material store.
- Raw materials are waiting to load in machine physically in machine shop.

We have observed the time of activities as well as entire operations along with associated factors such as waiting time, inspection time, and movement time. Description of Existing manufacturing cycle time & proposed manufacturing cycle time is shown in table. We go along these steps for reduction of manufacturing cycle time. Analyze the operation cycle time for each operation. "Existing operational cycle time "is written in table against each operation for each component and we are suggesting to: "proposed operational cycle time "by applying all the methodologies:

Toyota production system, Lean manufacturing concept (5'S & 7-Waste), GT-Group technology, U-cell formation, CAD/CAM application. Critical parts are long cycle items. It takes more and more time in manufacturing as per operation than other component's manufacturing time which is assembled in aircrafts or helicopters. Existing manufacturing cycle time includes the following time components:

1. Processing cycle time,
2. Compensatory relaxation allowance (C.R) time & Contingency allowance (C.A) time
3. Inspection time,
4. Part preparation time
5. Queuing time
6. The time taken in Zig-zag or criss-cross movement of materials from one machine to another machine or one place to another place for other operation.

Above all element of time takes (10-35) % of total manufacturing cycle time it is by observation of time study for Machining or processing time.

Our objective is to reduce the total existing manufacturing time to a range of extent by applications of different tools by focusing on the stages of flow of raw material and flow of semi-finished components.

a. The Compensatory relaxation allowance(C.R) time & Contingency allowance(C.A) time, inspection time, Part preparation time (arrange job ticket, rout card, drawing & instruction sheet), Queuing time and those are unidentified, are aimed to be reduced.
b. The existing manufacturing throughput cycle time is reduced up to Achieved / Arrived manufacturing throughput cycle time against each operation by
    1. using and applying of high technology for design and process (methodology and process change for operation).
    2. Using higher version machine e.g (3-Axis, 4-Axis machine, 5-Axis machine etc in place of conventional machines.
    3. CMM (Coordinate measuring machine) for inspection of complicated parts etc. which have complicated and intricate profile, in place of conventional way of inspection.
    4. Toyota Production System
    5. Cellular Manufacturing System
    6. LEAN Manufacturing Concept
    7. One piece flow system
    8. Self inspection by operator and machine itself
    9. Reduced batch quantity
    10. Increase no of components of same kind of operation means same or similar part families components.
    11. Decrease the no of batches or set up or batch size.

We have assumed self- inspection by machine operator itself and machine itself & one-piece flow concept , U-cellular concept in cell, a progress-person are available for immediate movement of parts/materials to reduce queuing time and finally it is checked by one inspector at last of U-cell or inspection should be done by operator itself. On above fixed condition, we have observed the existing manufacturing cycle time which are reduced to as Arrived manufacturing cycle time against each operation. Labor set up time is just as Machine set up time and Labor run time is just as Machine run time. As long as machine runs, so long as labor runs (i.e operator run time) similarly to machine set up time means time taken for setting the machine by labor (operator).

The factors involved to reduce the operation cycle time:

1. If quantity is increased, unit set up time is reduced.
2. If we use CNC machine instead of conventional machine, no of set up's time is reduced.
3. If we use CNC machine instead of conventional machine/Numerical controlled machine, programming time is reduced.
4. No. of passes based on material grains and its dimensional size for cutting is required for rough cutting or achieving final dimension as per drawing. The more pass is required for achieving final dimension of components.

Correct scheduling, plan and operational plan can reduce the preparation time. More quantity of same kind of components in size and profile whose operation is same or similar, less number of batches or set up also may lead to take less operational cycle time. Tool applied as Conventional Lath with applying tool of RMS (Reconfiguring manufacturing system), VSM, ,TQM, TPS, Zidoka, Kaizen, 3M,JIT,5s, Kanban, SMED, Pull system, SPC, Unit batch or reduced batch qty, Bottleneck as machine line balancing, TPM,GT, U-Cell formation, CM, CMM Inspection, Industry4.0 etc.

Data are collected at machine shop from ABC companies and associated suppliers & vendors. Data for manufacturing of DS component which transfer power as an input to a transmission system in an aircraft and helicopter are taken from ABC company and are morphed.

1. X Component

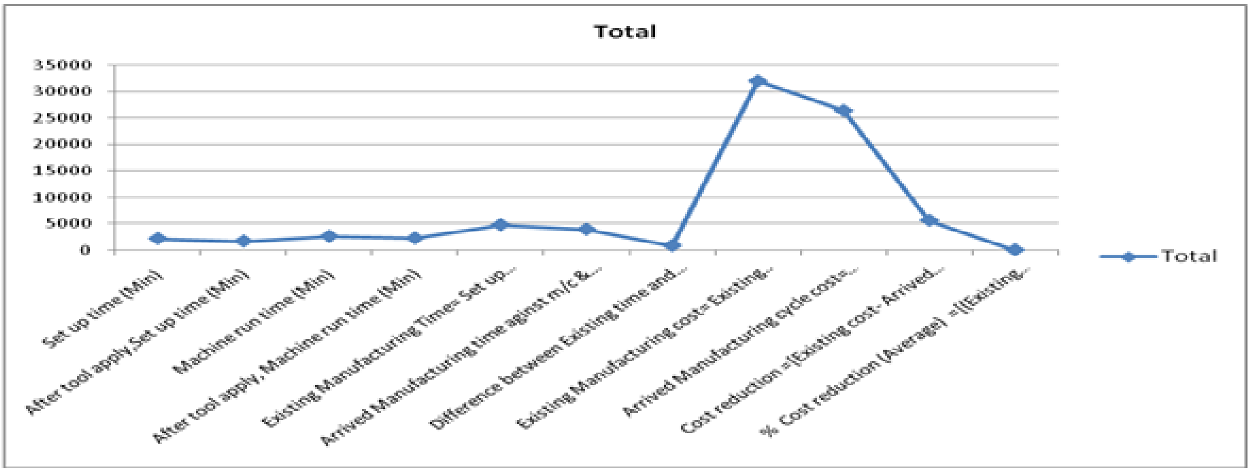
Data with (Conventional + Tool apply)

Machines, Bench	Operations	Set up time (Min)	After tool apply, Set up time (Min)	Machine run time (Min)	After tool apply, Machine run time (Min)	Existing Manufacturing Time = Set up time + Machine run time (Min)	Arrived Manufacturing time against m/c & operation after tools applying .(Improvement in Existing manufacturing system) (Min)	Difference between Existing time and Arrived time	MHR or Machine Hour Rate (Rs/Hr)	Existing Manufacturing cost= Existing manufacturing time (in Hrs.) X MHR (in Rs) or Existing operational cycle cost (In Rs)	Arrived Manufacturing cycle cost= Arrived operational time X MHR (in Rs)	Cost reduction =[Existing cost-Arrived cost] (In Rs)	% Cost reduction = [(Existing cost-Arrived cost) /Existing cost] *100 (In %)
Turret Lath	Turn as per IS	60	45	90	76	150	121	29	246	615	496	119	19
Turret Lath	Turn as per IS	60	46	30	24	90	70	20	246	369	287	82	22
Deep Hole Drill	Deep Drill as per IS	60	48	30	21	90	69	21	552	828	635	193	23
Conventional Lath	Turn as per IS	60	47	15	13	75	60	15	246	308	246	62	20
Conventional Lath	Turn as per IS	60	46	25	22	85	68	17	246	349	279	70	20
Conventional Lath	Turn as per IS	60	45	25	22	85	67	18	246	349	275	74	21
Conventional Lath	Turn as per IS	60	45	15	13	75	58	17	246	308	238	70	23
Conventional Lath	Turn as per IS	60	48	75	62	135	110	25	246	554	451	103	19
Conventional Lath	Turn as per IS	60	46	10	8	70	54	16	246	287	221	66	23
Center Hole Grinder	Clean center as per IS	60	46	11	8	71	54	17	591	699	532	167	24
Conventional Lath	Turn as per IS	60	48	90	79	150	127	23	246	615	521	94	15
Conventional Lath	Turn as per IS	60	47	10	3	70	50	20	246	287	205	82	29
Conventional Lath	Turn as per IS	60	49	20	14	80	63	17	246	328	258	70	21
Center Hole Grinder	Clean centers at both ends.	60	46	11	11	71	57	14	591	699	561	138	20
Cylindrical Grinder	Grind as per IS	60	47	80	64	140	111	29	591	1379	1093	286	21
Bench	Hone sharp edges	15	10	3	3	18	13	5	80	24	17	7	28

Gear Hobber	Cut Spline as per IS	180	155	75	61	255	216	39	1305	5546	4698	848	15
Bench	Debur	15	10	45	39	60	49	11	80	80	65	15	18
Horizontal Milling Machine	Saw off forged material and Mill as per IS	60	46	60	50	120	96	24	254	508	406	102	20
Heat Treatment	Fabricate test pieces	120	90	120	110	240	200	40	444	1776	1480	296	17
Process Shop	Copper plating as per IS	60	45	60	53	120	98	22	415	830	678	152	18
Process Shop	Remove copper plating as per IS	60	46	15	9	75	55	20	415	519	380	138	27
Process Shop	Vapor blasting	60	48	20	18	80	66	14	415	553	457	97	18
Center Hole Grinder	Clean center as per IS	60	47	11	10	71	57	14	591	699	561	138	20
Cylindrical Grinder	Between centers, clean face as per IS	60	48	25	25	85	73	12	591	837	719	118	14
Internal Grinder	Grind center as per IS	60	47	25	25	85	72	13	591	837	709	128	15
Cylindrical Grinder	Grind as per IS	60	48	50	47	110	95	15	591	1084	936	148	14
Universal Grinder	Grind as per IS	60	46	90	77	150	123	27	591	1478	1212	266	18
Conventional Lath	Turn as per IS	60	47	375	332	435	379	56	246	1784	1554	230	13
Bench	Hone sharp edges	15	10	35	31	50	41	9	80	67	55	12	18
Conventional Jig Bore	Jig bore as per IS	90	70	750	645	840	715	125	373	5222	4445	777	15
Drilling Machine	Drill as per IS	60	46	135	117	195	163	32	224	728	609	119	16
Bench	Deburr holes	15	11	40	36	55	47	8	80	73	63	11	15
Universal Grinder	Grind as per IS	60	46	30	20	90	66	24	591	887	650	236	27
Bench	Deburr	15	9	60	53	75	62	13	80	100	83	17	17
Conventional Lath	Turn as per IS	60	46	20	17	80	63	17	246	328	258	70	21
Bench	Part numbering	15	10	8	6	23	16	7	80	31	21	9	30
TOTAL		2160	1680	2589	2224	4749	3904	845		31962	26354	5608	18

Table-1	Total
∑Set up time (Min)	2160
∑After tool apply, Set up time (Min)	1680
∑Machine run time (Min)	2589
∑After tool apply, Mach ne run time (Min)	2224
∑Existing Manufacturing Time=[Set up time + Machine run time](Min)	4749
∑Arrived Manufacturing time aginst m/c & operation after tools app ying.(Improvement in Existing manufacturing syste) (Min)	3904
∑Difference between Existin time and Arrived time (Min)	845
∑Existing Manufacturing cost= Existing manufacturing time (in Hrs) X MHR (in Rs) or Existin operational cycle cost (In Rs)	31962
∑Arrived Manufacturing cycle cost= Arrived o erational time X MHR (in Rs)	26354
∑Cost reduction =[Existing cost- Arrived cost] (In Rs)	5608
% Cost reduction (Average) =[(Existing cost- Arrived cost)/Existing c t]*100 (In Rs).	20

Chart-1



FINDINGS/ RESULTS

1. Reduced the existing standard man hour (SMH).
2. Manpower is reduced for prefixed existing load on machines.
3. To deliver the components to customer on time or in less time.
4. To approach the innovative and creative methodologies in field of aviation manufacturing.

LIMITATIONS

1. Heat treatment shop & process shop should be in order or just near to machine shop to reduce the movement time of material for concerned operation.
2. A high valued capital machines are required.
3. Varieties of structural components and equipping components of aviation machines cannot be machined in one cell because of many operation but those are not as per order of machine layout.
4. Many components of medium & short cycle items having least operations & diversified operations, then all machines and materials cannot be uniformly balanced in term of loading on machines and machining. Hence capacity of machine shop may have to increase.
5. Lack of budget allocations for new technology and advance machines.

SIGNIFICANCE OF STUDY

1. Standard Man Hour SMH is reduced.
2. Timely delivery is possible for aerospace machines.
3. To reduce and control the excess hours which are used in conventional machine all kind.
4. Lead time reduction of components availability for assembly.
5. Cost reduction in manufacturing of detail components of aerospace machines.

REFERENCES

[1] (Feld, (2000).
[2] Gopalakrishnan, P. P. (1992). Cost Reduction Handbook. Jaico Publishing House, Bombay, Delhi, Bangalore, Calcutta, Hydrabad, Madras.
[3] Ghodsi, R. (2012). A bi- objective mathematical model toward dynamic cell formation considering labor utilization. Elsevier , 2308-2316.
[4] Patrix, J. L. (2013). Lean manufacturing: Costing the value stream . Industrial Management & Data Systems, Vol. 113 Iss: 5, pp. , 1-16.
[5] 5.Sabaghi, M. (2015). Kanban and value stream mapping analysis in lean manufacturing philosophy via simulation: a plastic fabrication (case study). Int. J. Services and Operations Management, Vol. 20, No. 1, , 118-140.
[6] Salma Shaheen, T. A. (2015). Linear Programming based Optimum Resource Utilization for Manufacturing of Electronic Toys. International Research Journal of Engineering and Technology (IRJET) , 261-264.
[7] G Srikantha Sharma & Dr. Kamal Vagrecha (2016). Investment Appraisal for repairable assets

using Performance costing approach: A case study on reliability ivestment on helicopter system. Imperial journal of Interdisciplinary Research (IJIR), 9 Issue-9, 1314-1323.

[8] S. Mahendran1, D. A. (2016). LEAN MANUFACTURING IN A MANUFACTURING INDUSTRY THROUGH VALUE STREAM MAPPING AND SIMULATION STUDY. International Journal of Advanced Engineering Technology E-ISSN 0976-3945 , 554-558.

[9] R. Suganthini Rekha, P. P. (2017). Manufacturing Enhancement through Reduction of Cycle Time using Different Lean Techniques . ICMAEM , 1-11.

[10] Abdul-Kader, S. Z. (2018). Cost Based Overall Equipment Effectiveness Analysis via Application of Value Stream Mapping. Proceedings of the International Conference on Industrial Engineering and Operations Management Washington DC, USA, (pp. 1024-1029).

[11] Mothilal, P. (2018). Implementation of Lean Tools in Apparel Industry to Improve Productivity and Quality. Juniper , 1-7.

[12] D.Aravind, R. M. (2018). IMPLEMENTING LEAN APPROACH IN LEAN TIME REDUCTION. International Journal of Advanced Science and Engineering Research, Volume: 3, Issue:1 , 1-5.

[13] Fadzil Adly Ishak, M. K. (2018). A case study of LEAN application for shortest lead time in composite repair shop . International Journal of Engineering & Technology , 112-119.

[14] S Indrawati1, A. A. (2019). Manufacturing Efficiency Improvement Through Lean Manufacturing Approach: A Case Study in A Steel Processing Industry . Annual Conference on Industrial and System Engineering (ACISE) 2019, (pp. 1-7).

[15] Sreekumar. (2019). Case Study of Application of Line Balancing to Value Stream Mapping for Process Improvement . International Journal for Research in Applied Science & Engineering Technology (IJRASET) , 488-494.

[16] FUKUZAWA, M. (2020). Function of Value Stream Mapping in Operations Management Journals. Annals of Business Administrative Science , 207-225.

[17] Julian Robecca, I. M. (2020). Product Quality Improvement by Using the Waste Assessment Model and Kipling Method . IOP Conf. Series: Materials Science and Engineering87 , 1-6.

[18] Sadiq, S. (2020). An integrated framework for lean manufacturing in relation with blue ocean manufacturing: A case study. Elsevier Journal of Cleaner Production. , 1-17.

[19] I C Gherghea, D. C. (2020). Waste reduction by implementation of CNC machining center and Lean Manufacturing. Annual Session of Scientific Papers - IMT , 1-10.