Manufacturing Throughput Cycle Time Reduction boosts Production rate and Cost advantages of components of Rotorcraft and Aircrafts in Aerospace Industries.

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Abstract: Manufacturing throughput cycle time reduction components of Rotorcrafts and Aircrafts is a very much challenging task in Aerospace manufacturing industries. Manufacturing time is influenced by many factors as lay out of machines, type of machines, management of machines utilization, type of machining operations, complex interaction of manufacturing. If different machining time or operations time is reduced, labour time will be reduced and delivery time of assembled product will be reduced. Manufacturing cycle time influences the cost of components and product as whole Rotorcrafts and Aircrafts. The reduction in operations time of long cycle components will effect a reduction in cost and delivery schedule to customers. The time reduction propels the cost reduction and cost reduction enhances the competitive cost advantage in manufacturing of Aerospace components.This research will give a direction to convert activities and operations into cost and reduction way of manufacturing throughput cycle time during all the operations.

Keyword: Throughput Cycle time, Cycle time reduction, manufacturing cycle cost, Cycle cost reduction, Rotorcraft and Aircrafts, Aerospace component.

Introduction: Manufacturing throughput cycle time is a time elapsed for a raw material or sub-assembly to move through all the manufacturing processes flow line. Manufacturing cycle time consists of machine set up time, machine processing time, quality inspection time, transportation or move time and waiting time to load in other machine etc and so on machines to machines. 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, the product waits to load in machine or transfer to a workstation, which undergoes further inspection and succeeding manufacturing processes. Manufacturing cycle time in manufacturing system consists of time elapsed in, from loading of raw material on machine to finish the product from machines, quality inspection of product or semi-finished with conformity, movement time and queue time under manufacturing processes.

The components of time in manufacturing are as- raw material loading on machine, waiting time to load on machine, machine set up time, machine or labor run time on machine, operation time or process time in machine, inspection time, movement of components from one machine to other machine, stage inspection time by inspector, movement time of components from machine to Heat treat shop and heat treatment process time, movement time of components from heat treatment to machine , again movement time of components from machine shop to process shop and it's processing time. All the activities are operations which are concerned with time elapsed to manufacture components. This research has applied many tools, approaches and methodologies to reduce time and cost of operations. The summation of time of entire path flow of components converting time into cost by factor of MHR-machine hour rate of different machines used for requisite operations.

Literature Review: The previous researchers have done a lot of work on manufacturing which are described and found gaps in the literature review.

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 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 [3]. 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 [4]. 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 [5]. 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 [6]. Review on Cycle Time Reduction in Manufacturing Industries by Hiten Patel & Sanjay C. Shah, 2014 [7]. 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,[8]. The initiation of effective preventative maintenance programs can be implemented for machines availability by Schonberger, 1996 [9]. A Throughput Time Study on Gemba through ABC Analysis for High Demand Product among Varieties of Products. Reductions in manufacturing throughput time increases flexibility and respond to customer orders supply on time by Raj Mohan R & V.Senthil Kumar, 2013 [10]. Time to be measured as per operation or activities where machine and man are working, Taylor, 1985 [11].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 to improve the production system through the reduction of time and costs. Helleno, A. L. (2015),[12].Kanban and value stream mapping analysis in lean manufacturing philosophy via simulation of a plastic fabrication for case study Sabaghi, M. (2015),[13].Every organization faces the problem of allocation of resources. The resources include men, machine, material, and capital, Salma Shaheen, T. A. (2015),[14].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 for aerospace composite manufacturing with several strength, Ch. Hueber, K. H. (2016),[15].Line balancing was done to improve the cycle efficiency by reducing the no of work stations and thereby decreasing the manpower required. Sreekumar. (2019),[16]. 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),[17]. The agile and practical methods for lean manufacturing and production process reengineering are in urgent need for Small and Medium Enterprises (SMEs).By integrating the internet of things (IoT) technology and Efficiency Validate Analysis (EVA) simulation framework by digital twin-enabled VSM approach for SMEs, Yangguang Lu, Z. L. (2021), [18]. Digitization in the production area represents the integrated planning and management of production and logistics systems and networks based on digital models, methods, and tools, which are built on a common flexible information and communication platform, Miriam Pekarcíková, P. T. (2021), [19]. This novel framework was developed based on a practical application of strategies such as improvements by ECRS (eliminate, combine, reduce, and simplify), standardized work (SW), and OEE (overall equipment effectiveness) control applied to the production processes to provide competitiveness' strategies to different branches of the industry for single-minute exchange of die (SMED) assisted by lean tools , Roberto Giani Pattaro Junior, R. H. (2022), [20].

The gap based on literature review and emphasize the rational of study.

Gap1: Many authors have done a lot of researches for manufacturing time reduction of automobile manufacturing, steel manufacturing, pharmaceutical equipments, domestic using tools and apparatus etc whereas here it is tried for manufacturing of Rotorcraft and Aircrafts components.

Gap2: Most of authors have done work on manufacturing reduction time for mostly short cycle components whereas here it is tried for reduction in manufacturing operational cycle time of critical and long cycle components of Rotorcrafts and Aircrafts of Aerospace industries.

Rational of Study: At present scenario, the operational throughput cycle time for manufacturing of detail components and critical components of Rotorcrafts and Aircrafts is very challenging and important. The structural detail components and critical components are defined as the components which are installed for functioning in different normal stage and critical stage of Rotorcrafts and Aircrafts. It works under high humidity, high temperature, high pressure high tension, compression, torque, moment, creep, high stress, high strain, high centrifugal stress & centrifugal strain, moment, momentum, angular momentum and fatigue conditions. Critical components are long cycle items; it takes more time to manufacture than other components. So I have focused on long cycle critical manufacturing components used in Rotorcrafts and Aircrafts. The significance of component's manufacturing is much higher with respect to functional sustainability and bear ability in different type of flying machines and aerospace machines.

Research issues: (Macro level): From the preceding Literature Review and gaps, the following research issues are identified:

1. Analysis of process time, queue time, inspection time, move time or transportation time during manufacturing the components.
2. Analysis of idle time of labor.
3. Analysis of machine break down.
4. Analysis of lost time in machine utilization w.r.t man, machine, material availability, tool availability etc.

Research objective (Micro level):

1. Analyze the activities involved in manufacturing from raw material to finish product in time measurement unit.
2. Measure the length of time of different operations under processing time, queue time, inspection time and move time.
3. Observe and note down the time against activities and operations during manufacturing.

4. Determine the manufacturing operational cycle time based on machine set up time, machining time, queue time, move time and inspection time.
5. Calculate the reduction time from existing and proposed state of manufacturing management system.
6. Calculate the reduction cost from existing and proposed state of manufacturing reduction time X Machine hour rate (MHR) of machines in manufacturing management system.

Research Methodology: The below tools are applied as on existing **c**onventional machines:

- JIT- Just in time
- TQM
- GT- Group technology
- CM- Cellular manufacturing
- Toyota production system
- Lean Manufacturing concept (5'S & 8-Waste)
- U-cell formation.
- Industry4.0 (Robotics, automation).
- CAD/CAM application

The above approaches /tools/ technique is applied as per requirement in manufacturing system and data are collected to analyze the research objective:

All the requisite activities should be value added time. There are many down time or break down time of machines and equipment, idle time of man / machine material and waste as rejection, scrap, rework, and defect. It is minimized fully or partially by using modern and latest technology having machines e.g. F.M.S—Flexible machining system, 3-Axis, 4-Axis, 5- axis CNC machine for a lot more operations at one time, Instead of conventional lath, CNC (computerized numerical control) lath & NC (Numerical control) lath should be used.

The detailed parts and Critical components are medium cycle and long cycle items. It takes more and more time in manufacturing as per operation than other component's manufacturing time which is assembled in Rotorcrafts and Aircrafts. 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.

The philosophy of reduction in manufacturing operational cycle time and operational cost reduction during manufacturing flow simultaneously in manufacturing management system.

The constituents of manufacturing flow line are as below in summation or integral form.

∑Manufacturing cycle time= [Machining or processing time + Compensatory relaxation allowance (CRA) time & Contingency allowance(C.A) time + inspection time + Set up time including Part preparation time (arrange job ticket, rout card , drawing & instruction sheet) + Queuing time + move time].

The formula for machine set up time is derived by analogy as below.

$$\text{Unit set up time} = \frac{(\text{Programming time + Involved activities setup time in machines}) \text{ x Batch or set up change}}{\text{Total Quantity}}$$

Symbolic formula as

Unit set up time= [(P+S)*B]/N

Whereas P= Machine's programming time,

S=All involved setup time in all different machines.

B=No of batches or no of set up,

N = Total Quantity

The factors involved to reduce the manufacturing 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 requisite size are required for machining to arrive final dimension as per drawing. The more pass is required for achieving final dimension of components. It can be reduced if CAD/CAM, automation and robotics are used in manufacturing management system.

Correct scheduling, plan and operational control can reduce the manufacturing time and preparation time of components. More quantity of same kind of components in size and profile whose operation is same or similar. The less number of batches or set up which are of part family components may also induce less operational throughput cycle time in manufacturing of Rotorcrafts and Aircrafts. Formula has been derived and used to calculate the % reduction in operational cycle time as well as operational cycle cost:

FORMULA:

$$\text{\% Manufacturing cycle time or cost Reduction} = \frac{(\text{Existing manufacturing cycle time or cost} - \text{Arrived manufacturing cycle time or cost})\text{X100}}{\text{Existing manufacturing cycle time or cost}}$$

The data are observed and collected of a Bevel Gear Tail Rotor Drive from ABC Aerospace company and their associates, suppliers and vendors which are morphed against each operation of existing manufacturing cycle time as well as cost. It shows the manufacturing operational cycle time as well as operational manufacturing cost in table respectively before tools apply and after tools apply. The Bevel Gear Tail Rotor Drive is a component of a flying machine which transfers high rotational power to another messed gear in order to their objective of power transmission. This type of component can be used in helicopter, UAV, Rotorcrafts and Aircrafts etc.

Bevel Gear Tail Rotor Drive:

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 %)
Conventional Lath	Hold in chuck to clean OD and facilitate for other operation.	60	45	15	11	75	56	19	246	308	230	78	25
Conventional Lath	Hold in Chuck and Turn as per IS (Instruction sheet)	60	48	80	70	140	118	22	246	574	484	90	16
Conventional Lath	Hold in soft Jaw and Turn as per IS except drilling operation.	60	46	150	130	210	176	34	246	861	722	139	16
Deep Hole Drill	Drill dia as per IS.	90	78	20	15	110	93	17	552	1012	856	156	15
Heat Treatment	Vapor blast	120	96	30	25	150	121	29	444	1110	895	215	19
Center Hole Grinder	Clean Centers on both sides.	60	48	15	11	75	59	16	591	739	581	158	21
Retro CNC Lath	Turn between centers as per IS.	68	55	25	18	93	73	20	743	1152	904	248	22
Retro CNC Lath	Turn between centers as per IS.	68	55	20	15	88	70	18	743	1090	867	223	20
Conventional Lath	Hold in fixture using steady rest and Turn as per IS.	60	45	120	95	180	140	40	246	738	574	164	22
Center Hole Grinder	Clean Centers on both sides.	60	46	20	10	80	56	24	591	788	552	236	30
Cylindrical Grind	Grinding between centers as per IS.	60	48	80	65	140	113	27	591	1379	1113	266	19
Gleason Gear Milling	Hold in fixture and cut spiral teeth as per IS.	180	150	60	48	240	198	42	1212	4848	4000	848	18
Bench	Deburr and form teeth as per IS.	15	11	135	110	150	121	29	80	200	161	39	19
Process Shop	Copper plating as per requisite area as per IS .	120	90	150	130	270	220	50	415	1868	1522	346	19

Process Shop	Gas carburizing along test piece as per IS .	120	90	15	11	135	101	34	415	934	699	235	25
Process Shop	Vapor blast.	60	45	30	20	90	65	25	415	623	450	173	28
Center Hole Grinder	Clean Centers on both sides as per IS	60	48	15	10	75	58	17	591	739	571	167	23
Retro CNC Lath	Turn between centers as per IS.	68	52	20	15	88	67	21	743	1090	830	260	24
Retro CNC Lath	Hold in soft Jaw and Turn as per IS.	68	52	15	12	83	64	19	743	1028	793	235	23
Horizontal Milling m/c	Hold in fixture and cut slots as per IS.	60	45	90	70	150	115	35	254	635	487	148	23
Bench	Deburr slots.	15	12	30	20	45	32	13	80	60	43	17	29
Horizontal Milling m/c	Hold in fixture and mill as per IS.	60	46	30	19	90	65	25	254	381	275	106	28
Bench	Deburring	10	7	15	11	25	18	7	80	33	24	9	28
Cylindrical Grind	Grinding dia between centers as per IS.	60	45	60	48	120	93	27	591	1182	916	266	23
Process Shop	Copper plating up to 0.025 thickness all over the length.	120	85	45	30	165	115	50	415	1141	795	346	30
Process Shop	Copper plate strip along tensile and impact.	120	85	20	13	140	98	42	415	968	678	291	30
Process Shop	Vapor blast	60	45	30	18	90	63	27	415	623	436	187	30
Internal Grinder.	Load on pitch line locator and grind as per IS.	60	45	15	9	75	54	21	591	739	532	207	28
Center Hole Grinder	Clean Centers on both sides.	60	46	20	13	80	59	21	591	788	581	207	26
Cylindrical Grind	Grind between centers as per IS.	60	48	50	32	110	80	30	591	1084	788	296	27
Cylindrical Grind	Hold in between and grinds as per IS.	60	47	15	10	75	57	18	591	739	561	177	24
Internal Grinder.	Hold in soft Jaws and Grind the bore as per IS.	60	45	15	10	75	55	20	591	739	542	197	27
Broaching Machine	Hold in fixture and broach as per IS.	65	49	7	5	72	54	18	530	636	477	159	25
Bench	Deburr the teeth.	15	10	35	21	50	31	19	80	67	41	25	38
Gleason Gear Milling	Locate in fixture and grind as per IS.	180	150	45	30	225	180	45	1212	4545	3636	909	20
Bench	Hone the sharp edges.	20	15	25	15	45	30	15	80	60	40	20	33
Thread Grinding	Thread Grinding between centers as per IS.	180	155	60	46	240	201	39	3131	12524	10489	2035	16
Gleason Gear Grinding.	Hold in fixture and grind spiral teeth as per IS.	180	155	45	31	225	186	39	3131	11741	9706	203 5	17
Bench	Deburr the teeth and break sharp edges all over the length.	15	9	150	132	165	141	24	80	220	188	32	15
Process Shop	Super finishing the teeth as per IS.	60	46	35	22	95	68	27	415	657	470	187	28
Bench	Part Numbering.	6	5	4	3	10	8	2	80	13	11	3	20
TOTAL		2983	2343	1856	1429	4839	3772	1067		60652	**48517**	**12135**	20

Table-1

	Total
Set up time (Min)	2983
After tool apply, Set up time (Min)	2343
Machine run time (Min)	1856
After tool apply, Machine run time (Min)	1429
Existing Manufacturing Time= Set up time + Machine run time (Min)	4839
Arrived Manufacturing time against m/c & operation after tools applying.(Improvement in Existing manufacturing system) (Min)	3772
Difference between Existing time and Arrived time	1067
Existing Manufacturing cost= Existing manufacturing time (in Hrs) X MHR (in Rs) or Existing operational cycle cost (In Rs)	60652
Arrived Manufacturing cycle cost= Arrived operational time X MHR (in Rs)	48517
Cost reduction =[Existing cost- Arrived cost] (In Rs)	12135
% Cost reduction = [(Existing cost- Arrived cost)/Existing cost]*100 (In %)	20

Below all the charts show a graphical model presentation from analytics of mathematical relations among existing and applied methods.

Chart-1

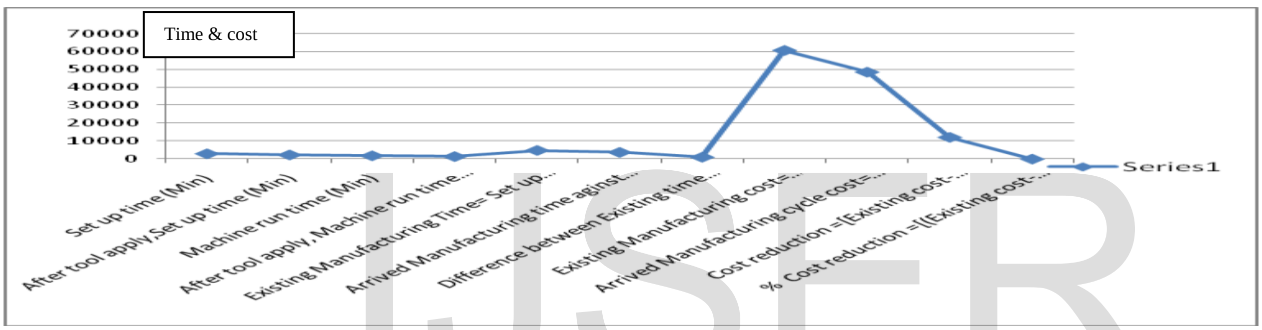


Table-2

	Existing	After tool apply
Set up time (Min)	2983	2343
Machine run time (Min)	1856	1429
Manufacturing Time= Set up time + Machine run time (Min)	4839	3772
Manufacturing cost= Existing manufacturing time (in Hrs) X MHR (in Rs) or Existing operational cycle cost (In Rs)	60652	48517

Chart-2

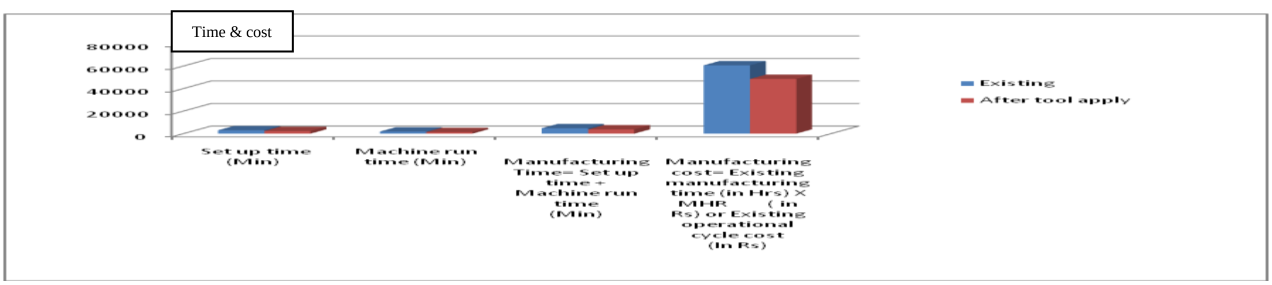


Table-3

	Time
Existing Manufacturing Time= Set up time + Machine run time (Min)	4839
Arrived Manufacturing time against m/c & operation after tools applying.(Improvement in Existing manufacturing system) (Min)	3772
Difference between Existing time and Arrived time (Min)	1067
% of Average Time reduction = [(Existing time- Arrived time)/Existing time]*100 (In %)	22

Chart-3

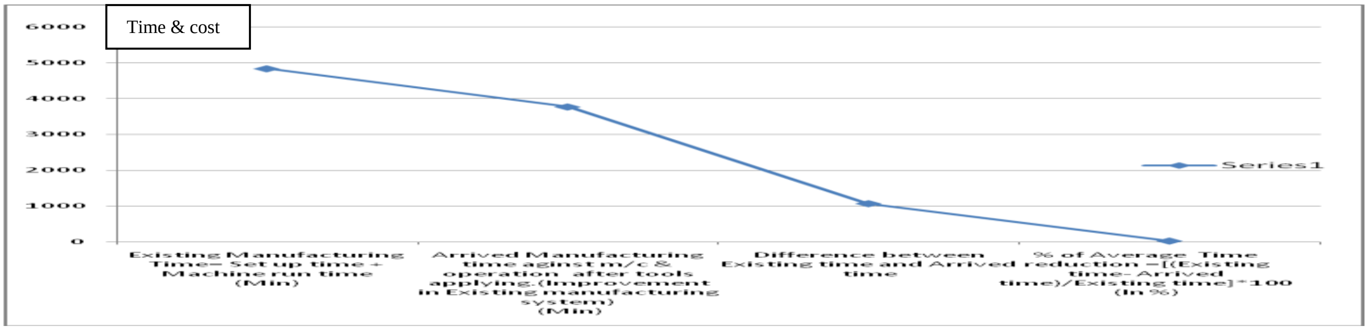
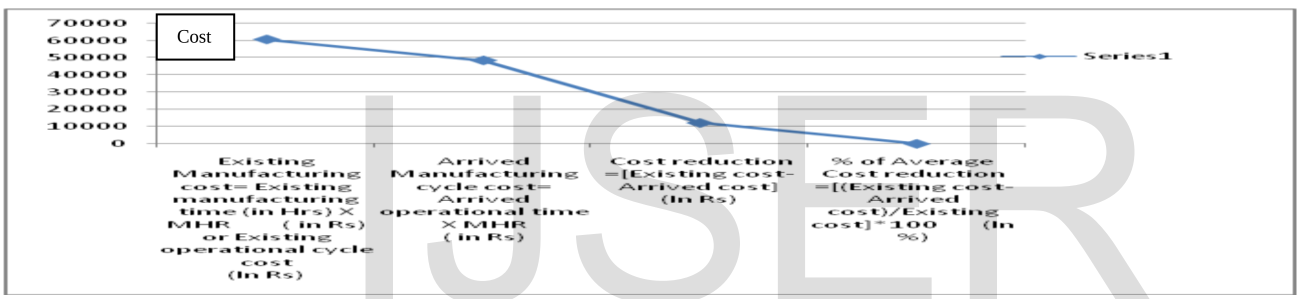


Table-4

Existing Manufacturing cost= Existing manufacturing time (in Hrs) X MHR (in Rs) or Existing operational cycle cost (In Rs)	60652
Arrived Manufacturing cycle cost= Arrived operational time X MHR (in Rs)	48517
Cost reduction =[Existing cost- Arrived cost] (In Rs)	12135
% of Average Cost reduction = [(Existing cost- Arrived cost)/Existing cost]*100 (In %)	24

Chart-4



I have measured the time and established a correlation with basic machining time by observation of activities of as movement time (M=@30% of B.T), Queue time (Q=@25%of B.T), Inspection time (I=@20%of B.T).where B.T is basic time. This is based on after measuring the value and established the relation among them.

Table-5

Operations / Activities	Existing	Arrived after tool apply
Manufacturing operation Cycle Time= (Total machine set up time+ Total machine run time) (In Min)	4839	3772
Movement time= @30% of Basic total time (In Min)	1452	1132
Queue time or Waiting time = @25% of Basic time (In Min)	1210	943
Inspection time = @20% of Basic time (In Min)	968	754
Total Throughput MCT (In Min)	8468	6601

Chart-5

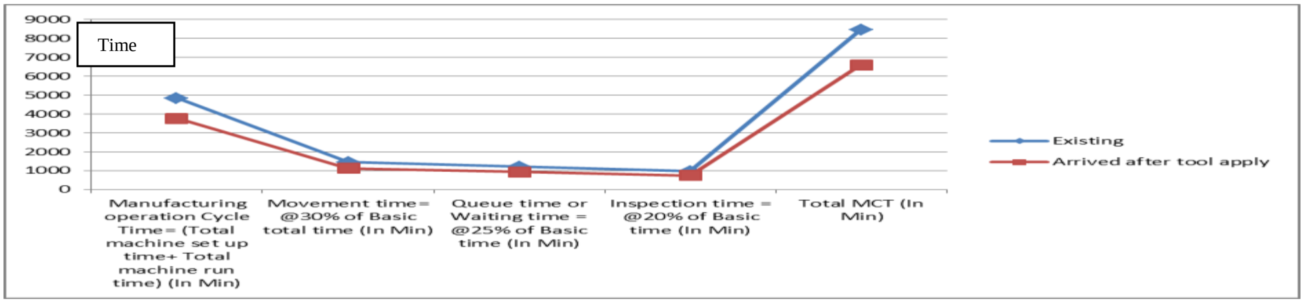


Table-6

Operations / Activities	Existing	Arrived after tool apply
Total Manufacturing operation Cycle Cost (MCC) (In Rs)	60652	48517
Movement Cost = Movement time/60 x SMHR @ Rs 1020 (in Rs)	24679	19237
Queue Cost or Waiting Cost = Queue or Waiting time/60 x SMHR @ Rs 1020 (In Rs)	20566	16031
Inspection Cost = Inspection Time/60 x SMHR @ Rs 1020 (In Rs)	16453	12825
Total Throughput MCC (Rs)	122349	96610

Chart-6

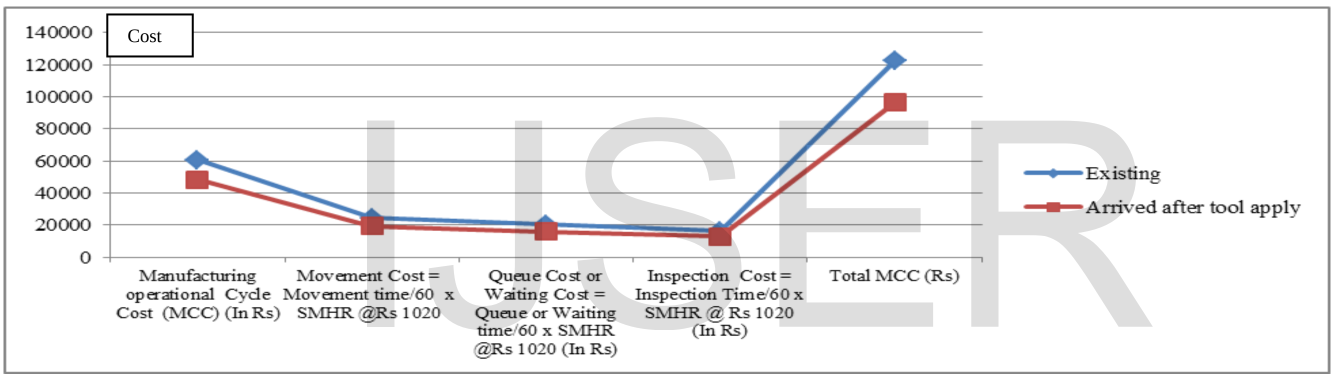


Table-7

Time & Cost	Existing	Arrived by tool apply
Total Throughput MCT (Min) = (Manufacturing time+ Movement time + Queue time + Inspection time)	8468	6601
Total Throughput MCC (Rs) = (Manufacturing operation cost + Movement cost + Queue cost + Inspection cost)	122349	96610

Chart-7

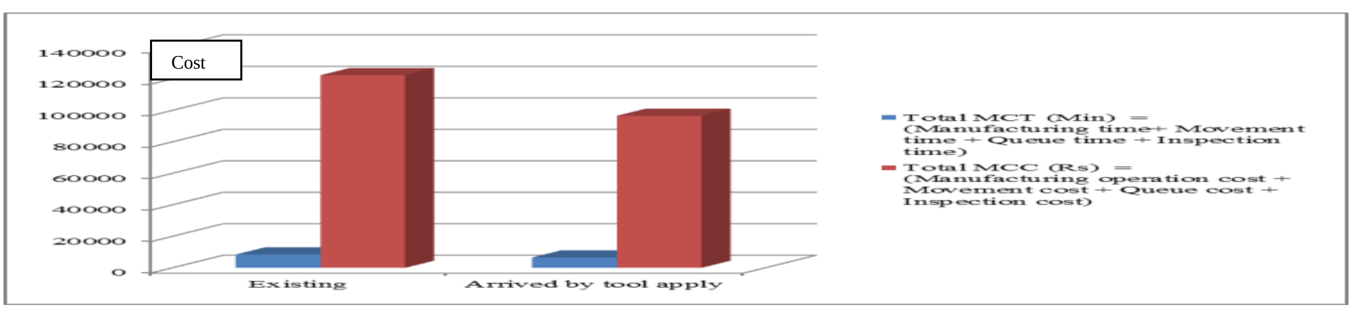
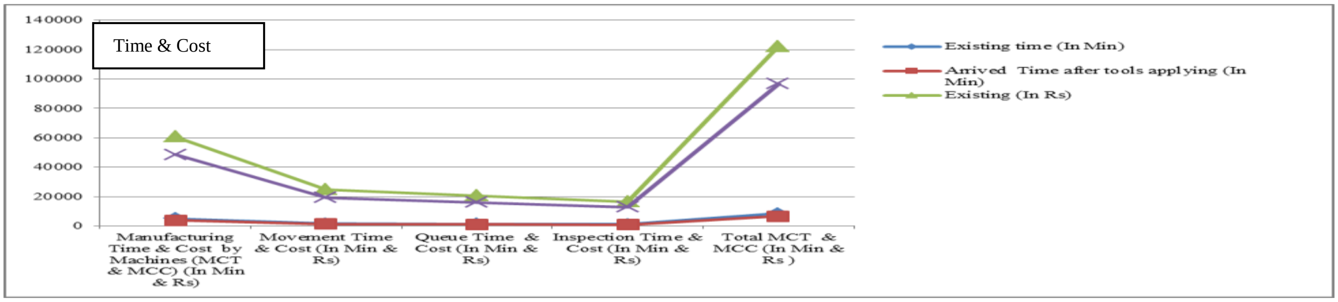


Table-8

Operations	Existing time (In Min)	Arrived Time after tools applying (In Min)	Existing (In Rs)	Arrived after tool apply (In Rs)

Manufacturing Time & Cost by Machines (MCT & MCC) (In Min & Rs)	4839	3772	60652	48517
Movement Time & Cost (In Min & Rs)	1452	1132	24679	19237
Queue Time & Cost (In Min & Rs)	1210	943	20566	16031
Inspection Time & Cost (In Min & Cost)	968	754	16453	12825
Total Throughput MCT & MCC (In Min & Rs)	8468	6601	122349	96610

Chart-8



Quality improvement:

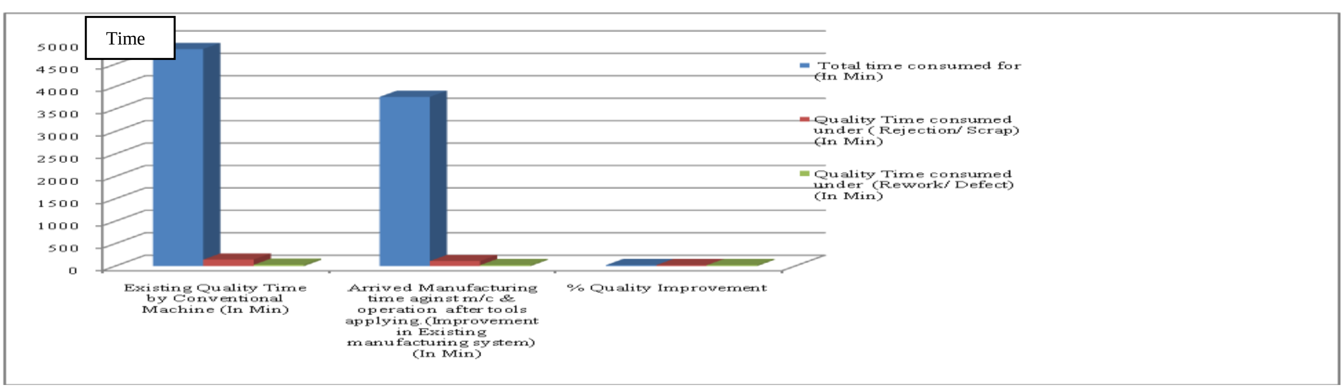
Quality improvement by enhancing the modern technologies as CNC machines, automation , robotics, JIT & Lean application as reduced rework , defects and rejection through below data and charts.

Rejection time on an average per quantity per month in Machine shop for manufacturing of this component and collected data are as below.

Table-9

Activities/Operations	Existing Quality Time by Conventional Machine (In Min)	Arrived Manufacturing time against m/c & operation after tools applying.(Improvement in Existing manufacturing system) (In Min)	% Quality Improvement
Total time consumed for (In Min)	4839	3772	22
Quality Time consumed under (Rejection/ Scrap) (In Min)	145	112	23
Quality Time consumed under (Rework/ Defect) (In Min)	28	22	21

Chart-9



Conclusion: The results can be concluded through below table.

Table-10

Operations	Existing time (In Min)	Arrived Time after tools applying (In Min)	Existing cost (In Rs)	Arrived cost after tool apply (In Rs)

Total Throughput MCT & MCC (In Min & Rs)	8468	6601	122349	96610

This is an illustration of a model of one component. If applied methodologies are generalized for all the components of different part family of Rotorcrafts and Aircrafts, it will provide a great deal of cost advantage in Rotorcrafts and Aircrafts of Aerospace industries.

I have concluded in a debrief as [TMCT- Throughput Manufacturing Cycle Time, TMCC- Throughput Manufacturing Cycle Cost]

The production rate w.r.t time and cost is occurred as:

Production rate w.r.t time = [Existing Manufacturing Cycle Time/Arrived Manufacturing Time].

=8468/6601 = 1.28 = [1+0.28].

It means manufacturing production rate is increased by 28% w.r.t time.

Productivity w.r.t Cost = [Existing Manufacturing Cycle Cost/Arrived Manufacturing Cost].

= 122349/96610= 1.26 = [1+0.26].

It means total throughput manufacturing cycle time shows that production rate is increased by 28% and similarly manufacturing cost-effectiveness and productivity is increased by 26%. In another word, I can say the amount of the reduced manufacturing throughput cycle time produces extra components by 28% and similarly the reduced cost can boost cost advantages for business growth. Hence it can be concluded that production rate can have cost advantage by 26%.

The amount of cost reduction in manufacturing enhances the revenue generation towards business growth. Impact of time cum cost reduction enhances the business growth, production rate, productivity and revenue generation by cost advantage during manufacturing of components of Rotorcrafts and Aircrafts or in any Aerospace and Aviation industries. Thus It is generalized that all components of Rotorcrafts and Aircrafts of Aerospace Industries keeping manufacturing time reduction advantage boosts cost advantage during manufacturing process flow line and it enhances the business growth in Aerospace industries by increased production rate in order to competitive cost advantage of Rotorcraft and Aircraft's components and their assembly production rate.

Findings/ Results:

1) This research has deduced an analytical model to convert all operational activities time of manufacturing machines into manufacturing labor cost and their reduction in time as well as cost.

2) The manufacturing cycle time is reduced.

3) The manufacturing cycle cost is reduced.

4) Reduced the idle time of man and machines during manufacturing.

5) Man power is reduced for prefixed existing load on machines.

7) The movement of components is reduced.

8) The delivery time of the manufactured components to customer is reduced.

9) Production rate, Productivity as well as business growth is enhanced by 26 % to 28% in helicopter Industries.

10) The customers will get competitive cost advantage of 26% to 28% as component-wise and assembled Rotorcrafts and Aircrafts wise and even any products of Aerospace Industries.

Limitations:

1) It requires a provisioning of high cost machines and high capital for layout changes.

2) It requires skilled man power & machine capacity enhancement.

3) It needs more space to install the necessary plant engineering to assist smooth flow of raw material during manufacturing. Hence space constraint in machine shop area will occur.

4) There will be a lack of budget allocations for new technology and advance machines.

5) Revival of old machine with contemporary technology, a high capital is required to purchase new technologies.

6) Space constraint can counter with normal space availability in cell or near to cell of machines in machine shop to set up the small sized heat treatment shop and processing shop.

7) Skilled operators are required for CNC machine operation.

8) Many components of medium & short cycle items having least operations & diversified operations, then all machines and materials cannot be uniformly loaded as line balancing for machining operation. Hence capacity of machine shop may have to be augmented.

Significance of study:

1) It gives a model of philosophy and awareness to focus on detailed critical components to optimize entire activities during manufacturing w.r.t time & cost reduction, quality improvement and waste reduction in aviation industries.

2) This research gives a generic analytical model to convert any activities of operational flow line into cost of Rotorcrafts and Aircrafts manufacturing activities or even any Industrial activities also.

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