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PRODUCTIVITY IMPROVEMENT OF GEAR BOX ASSEMBLY IN T-72 TANK

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ABSTRACT

Government of India has promulgated a policy for "Make in India" to promote the MSME and Indian Vendors. It also changed the image of the country as a hub for manufacturing but also as a destination to do business. The government of India aims to turn the country into a Defence manufacturing powerhouse. It offers a way of improving the country's self-reliance in Defence production. This project focuses on the crucial area of productivity improvement with the astute use of work study technique and lean tools mixed with skills in Defence production. The systematic application of time study, lean tools helps to improve productivity, reduce costs and improve profits. This project is indented to study the cycle time of existing method of different work stations and suggesting improved methods for the same as to reduce the cycle time and improve the productivity of overhauling of side gear box tank T-72. It aims to finding the best and the most efficient way of utilising the available resources to achieve the best possible quality of work in minimum possible time and cause least possible fatigue to the worker. This research focuses on the productivity improvement in Gear Box Assemblyin a manufacturing hub with respect to existingmethods and its implications in increasing productivity through varied methods.

Keywords:

Gear Box Assembly, Side Gear box, Productivity, Time Study, Value Stream Mapping

INTRODUCTION

The Ministry of Defence, the Defence Acquisition Council (DAC) has spearheaded Defence deals worth more than Rs. 82,000 Crores under the tag 'buy and make Indian' and 'buy Indian'. The above deals include procurement of light combat aircraft (LCA), mini-unmanned aerial vehicles (UAV), light combat helicopters and also T-90 tanks (Bhisma Battle Tanks). India is one of the largest importers of technology transfer in defence equipment and spends nearly 30% of its total defence spending on capital acquisitions. Defence related requirements amounting to 60% are met by imports. The Indian government's make in India focuses on expanding domestic defence manufacturing to become self-reliant India's focus on indigenous manufacturing in the defence sector has paved way for the Ministry

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of Defence over the last four years to unveil various products manufactured in India.

Side Gear Box is one of the main system in the Tank T-72 & T-90. The make in India concept by the government of India has led to indigenisation and in house manufacturing of Side Gear Box in order to promote the make in India concept keeping in mind to improve productivity.

Productivity is defined as the ratio between output and input. Most of the people are confused between production and productivity. Productivity is actually deviated from production. It is concerned with increment in output for a given period of time. In other words, productivity improvement has to do with how efficiently people utilize different resources for manufacturing components and services which many others dream to purchase. Enhanced production, elevated and high volume of incomes can be accomplished for every hour worked with the appropriate choices.

With the raise in demand of various products and commodities, manufacturing industries have to focus on increasing their potentials in production, effectiveness and quality of service in order to compete with their competitors. At the same time, the production process should be framed with the ability to eliminate non-value added costs with higher proficiency. Therefore, the methods to solve the problems regarding the production are of paramount importance. Some of the ways for solving problems concerning and governing productivity are setup reduction (SUR), cycle time reduction, standardize work (SDW), waste elimination, etc.

Side Gear Box

A Side gear boxes perform the function of transmitting the engine torque from the transmission gear box to the final drives, varying the speed and tractive effort for turning, braking and for disengaging the engine from drive sprockets. All these are achieved by engaging the appropriate friction sets in the side gear boxes. Each gear box consists of four epicycle gear trains, friction clutches, brakes, and hydraulic boosters to engage the clutches and brakes. There is a fifth epicycle gear train the final drive. The gear boxes provide seven forward and one reverse speeds.

Epicyclic Gear Train

An epicyclical gear train consists of a sun pinion, an internal gear ring called annulus and set of planetary pinions mounted on a carrier. When one member is fixed, and input given to one of the remaining two members, the third member gives the output, whose speed will have a fixed ratio to the input speed. The gear train can be used to provide any one of the six speed ratios, viz, two over drives, two reductions and two reverse speeds. When two members are interlocked a direct drive of speed ratio 1:1 can be obtained. The ratio between input and output speeds can be calculated from vector diagrams.Epicyclical gear trains can also be compounded to give different gear ratios. Two epicycle gear trains compounded give three speed ratios by releasing or engaging the clutch & brakes.

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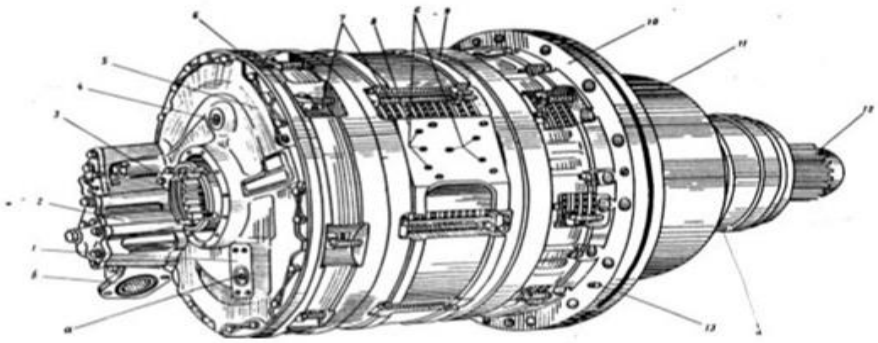
Construction of Side Gear Boxes

The left and right side gear boxes are similar in construction except that, the left side gear box contains an oil feed pump for feeding oil under pressure to the common hydraulic control and power train lubrication system. The casing of the left side gear box has a platform for mounting of a cyclonic filter. The side gear boxes are constructional combined with final drives of the respective sides. External view of the side gear boxes with final drives are given in Figure below.



1- Platform for attachment of hydrocyclone ; 2-Delivery pump; 3- Gear box suction pump; 4- Gear box oil suction duct; 5-Front flange; 6-Packing ring; 7- Throw-out devices; 8-Platform for attachment of distributing mechanism; 9-Middle drum; 10-Rear flange; 11- Final drive cover; 12-Final drive shaft; 13-Gear box oil supply bushing; a-hydrocyclone oil supply duct; b-Delivery pump intake duct; c-Gear box boosters oil supply ducts

Fig. 1: External view of the Side Gear Boxes

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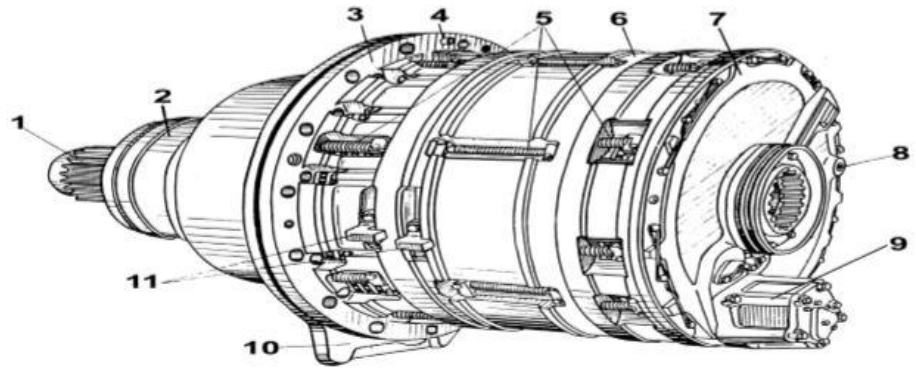

1- Final drive shaft; 2- Final drive cover; 3- Gearbox rear flange; 4- Gear box oil supply bushing; 5- throw –out devices ; 6- Middle drum; 7- Front flange; 8- Duct for suction of oil out of gear box; 9-Gear box suction pump; 10- Final drive lug;11-Uprights with stops;

Fig. 2: Construction of Side Gear Box (Left)

Function of Side gear boxes during steering

Steering of the vehicle is achieved as follows: -

During the motion of the vehicle in any gear except first and reverse, complete pulling of a steering stick causes engagement of a lower gear in one of the side gear boxes (same side as the steering stick is pulled). This results in reduction in speed of the inner track, and the vehicle is turned at a certain fixed turning radius. When the vehicle is traveling in first or reverse gear, brake is applied in the side gear box of the inner side and turning is accomplished at a radius equal to the width of the vehicle (skid turn). Each forward gear gives a different turning radius, irrespective of the speed of the vehicle.Partial pulling of the stick causes partial engagement of the frictional elements and a larger turning radius will be achieved.

Lubrication of side gear boxes

For lubricating and cooling the parts of the side gear box, oil are delivered under pressure from the hydraulic control and power train lubricating system, through a duct in the external flange. After lubricating and cooling the bearing, planetary gear trains and friction discs, the oil drops into the space of the housing and is transferred to the oil tank by the oil scavenging pump.

METHODOLOGY

There are 11 major sub-assemblies are in the Side Gear Box. This is one of the critical assy which is

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manufacturing in-house as part of make in India concept for productivity improvement. Hence, Side Gear Box assy was selected for the study. There are various methods that are used for achieving the objectives. Data collection and observation is primary requirement of the study. Before analysis of data, complete collection of field data was undertaken. Based on the data collection and their analysis, identification of the various problems and non-value added activities were done. Finally the result was obtained from the testing data which was subsequently used to cater for the objective requirement.

The details of operations involved in testing of Side Gear Box are:

- Collection of one year Production Data
- Collection failure data for machine, test jig etc
- Collection of current flow process for assy of gear box
- Collection of availability of man hour and assessing their skill.
- In depth study of failure and its cause through QC tools
- Improving the productivity through Lean tools viz. Value Stream Mapping.

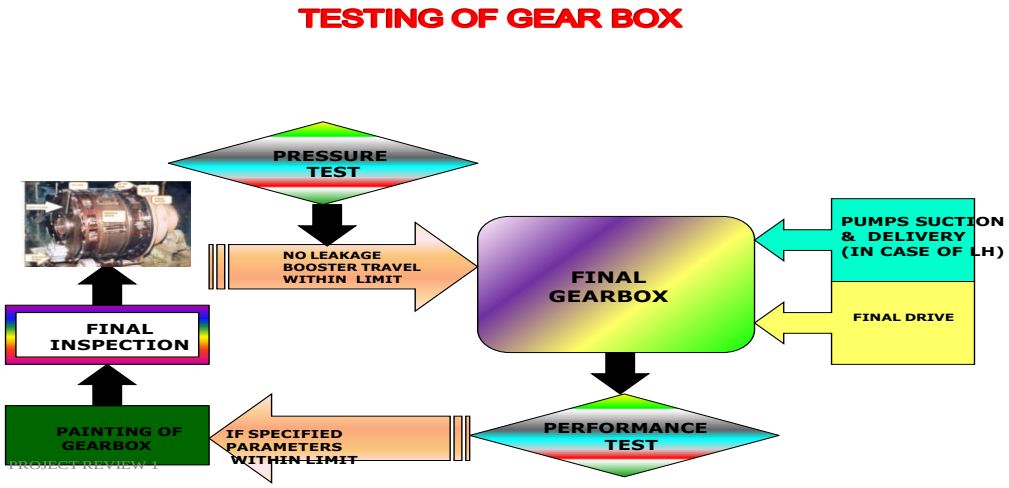

Fig. 3: Testing of Gear Box

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Table 1: Details of various Operations involved and time consumed in testing of Side Gear Box

Operations involved	Present time involved minutes	Proposed time calculated minutes	Saving time minutes
Dismantling into sub assy level	120	90	30
Transport for washing and inspection point	180	140	40
Inspection of components as per Process/ drawing	1020	900	120
Transport the sub-assemblies to leak test & Balancing to other Shop	180	60	120
Sending the item for Rectification if any Non Conformity noticed	300	180	120
Assembly of sub assy/ components into major assy	3600	3000	600
Pressure Test of SGB	45	45	0
Performance test of SGB	60	45	15
Cumulative Minutes	**5505**	**4460**	**1045**

Table 2: Time Study Calculation (First Sun Gear Assembly)

Operations involved	Present time involved minutes	Proposed time calculated minutes	Saving time minutes
Dismantling into sub assy level	45	45	-
Transport for washing and inspection point	20	20	-
Inspection of components as per Process/ drawing	45	25	20
Transport the sub-assemblies to leak test & Balancing to other Shop	180	60	120
Sending the item for Rectification if any Non Conformity noticed	120	120	-
Assembly of sub assy/components into major assy	240	200.	40
Cumulative minutes	**650**	**470**	**180**

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Fig. 4: New Balancing Machine

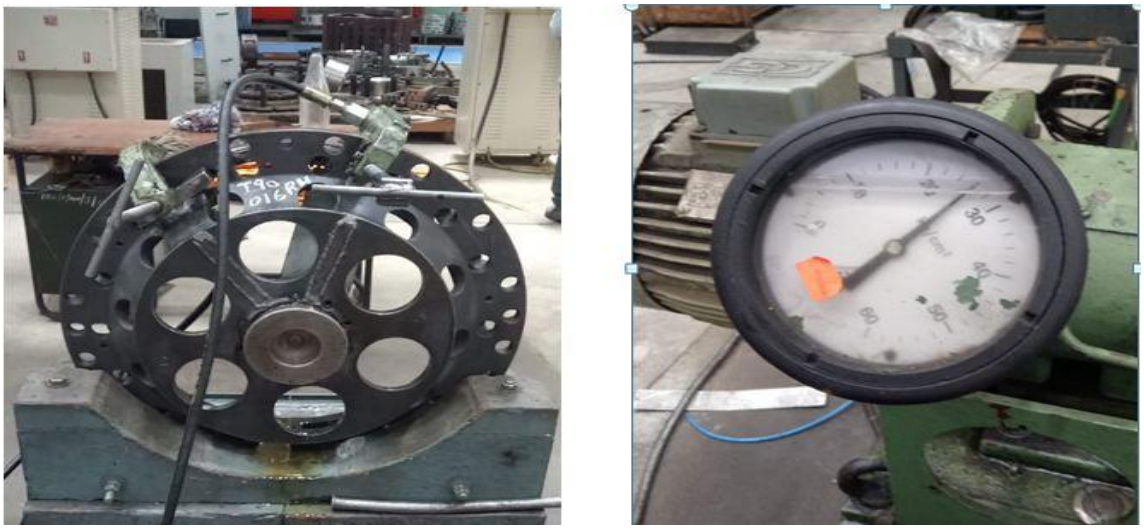

Fig. 5: Leak Test: Front Flange

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RESULT AND DISCUSSION

Table 3: Time calculation through Arena software

Method	Value added time	Waiting time	Total time
Old method	91.765 hrs	7.97 hrs	99.438 hrs
Improved set up with same manpower	74.312 hrs	2.89 hrs	77.219 hrs
Improved set up with reduced manpower	74.313 hrs	8.379 hrs	82.680 hrs

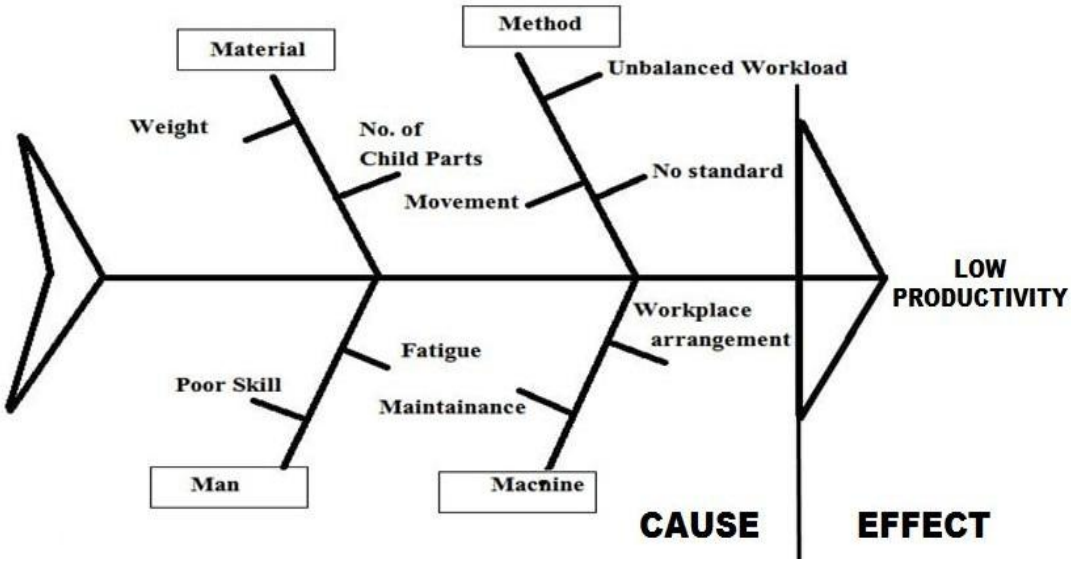

Fig.6: Validation through Cause and Effect Diagram

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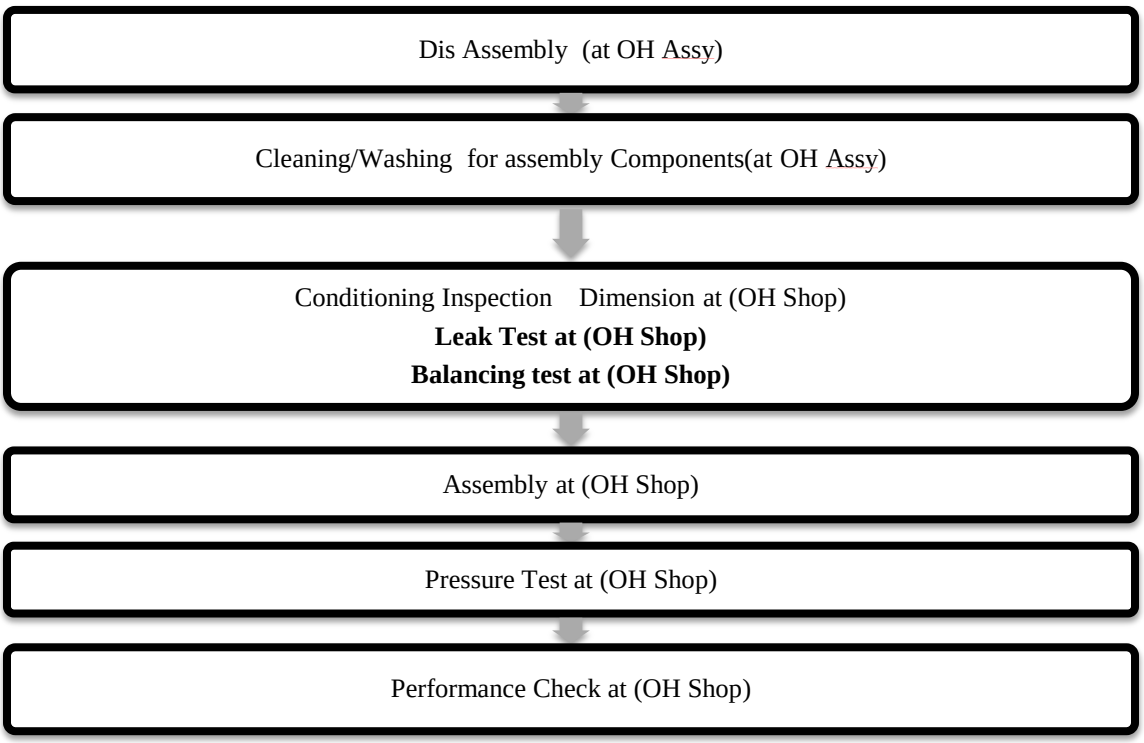
Table 4: Main Groups of Production Line Downtimes

Sl. No	Group	Description	Downtime (min)
1	Planned downtime	Breakfast break, cleaning, top-down production stoppage.	90
2	Unplanned downtime	Unplanned production stoppage, for example, due to lack of components.	45
3	Failure	Extended unplanned machine breakdown due to technical stoppage.	3 days / month
4	Micro Failure	Short production stoppage that does not require calling for maintenance services.	30 min for filling up grinding powder, Oil

Table 5: Proposal Flow Process



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CONCLUSION

The study enabled us to estimate the material, labour and operating cost involved in Overhauling of Side Gear Box. It gives the basis for improving productivity by various work measurement techniques viz. time study, 5S Activities and Value stream mapping and Arena Simulation Software. Unwanted movement of person and Job for the mandated QA Parameters checks as per ToT have been reduced by introduction / installing a new 'New Balancing Machine and leak test facility at Overhauled shop.Unwanted Operator movement for getting items/ tools for assembly has been minimized by introduction of Two Hand Motion through"5S" activities. Introduction of Online inspection methods has been introduced resulting time saving in inspection. After implementation of above improvements Overhaul production has been increased by 15% from existing production.

REFERENCES

[1] Patrick Moe, Nelson Cheng,*Preservation Technical Journal of the Main Battle Tank*, International Journal of Pure and Applied Mathematics, 2016

[2] Rajesh Kumar Jagath, *Design Configuration of a Generation Next Main Battle Tank for Future Combat*, Defence Science Journal, 2017

[3] T. L. H. Butterfield,*Design and Development of Fighting Tanks*, International Research Journal of Engineering and Technology, 2019