

**REDUCTION IN THROUGHPUT TIME OF PROPELLER SHAFT
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Abstract — *Integration of machining operation is mandatory in order to achieve desired manufacturing cost and time. It includes improvement of tooling devices. It includes fixtures which help in locating clamps and supporting workpieces. They play an important role in integration of operations. This project includes manufacturing of half end yoke which is a part of universal joint. This aim gives rise to need of modifying the fixture due to its incapability towards integration of operations. The primary objective of the project is to develop a fixture such that it will serve its functions and allow the integrated operations to be performed so as to reduce the throughput time for propeller shaft. The fixture was designed on basis of three principles namely location, support and clamping. The foremost concern during the designing phase was that its operation should be easy and comfortable for the operator. After the design and manufacturing and design of fixture it was put to test. The results of the test and inspections were positive. The design had several advantages but it also gave rise to some of the limitations. There is a scope to overcome these limitations in future by improving on design.*

Keywords- *Propeller shaft, throughput time, companion flange, CB kit assembly, fixture.*

I. INTRODUCTION

A Shaft transmitting power from an engine to a propeller or to the wheels of a motor vehicle is generally what we call a propeller shaft. It basically connects the transmission shaft to the pinion shaft at the wheel axle. The functions of propeller shaft include:

- It transmits rotary motion of gearbox output shaft to the differential and then to the wheels through the axle shaft.
- It transmits motion at an angle which is varying frequently.
- It accommodates changes in length between the gear box and rear axle.

Propeller shaft consists mainly of three parts those are shaft, universal joint and a slip joint. The shaft has to withstand mainly torsional loads. It has to be well balanced to avoid whirling at high speeds. Depending upon the rear axle drive the number of universal joints may be varied as one or two. When the vehicle is running the universal joint accounts for up and down moment of rear axle. The slip joint serves to adjust the length of the propeller shaft when demanded by the rear axle moments. The universal joint or hooks joint is used to connect two shafts which are inclined to each other. Main parts of universal joint are driving yoke, driven yoke, spider and trunnions

When manufacturing of propeller shaft is taken into consideration, it is important that precision and accuracy should be followed also one of the main function to be considered is its through put time. It plays a vital role during the manufacturing process.

- **Throughput time:** Manufacturing throughout time is the amount of time required for a product to pass through a manufacturing process, thereby being converted from raw materials into finished good. The concept also applies to the processing of raw materials into a component or sub-assembly. Throughput time is a time elapsed required for a raw material or sub-assembly to let through a manufacturing process following the release of an order to the manufacturing. Throughput time consists of process time, quality inspection time, transportation time and waiting time. Process time is the time period during which work is performed on the product itself. Inspection time is the time during which the quality of the product is confirmed. Transportation time is the time during which materials or works-in-process are moved from one workstation to another. Queue time is the phase of time during which the product awaits transfer to a workstation, undergoes further inspection and succeeding manufacturing processes. Reductions in manufacturing throughput time increase flexibility and reduce the time required to respond to customer orders. This can be vital to the survival and profitability of numerous firms, especially those experiencing increased market pressures for shorter delivery lead times of customized product. This is essential to survive in the present competitive market where in the costs are major concerns. Therefore, in order to remain competitive, waste from inventory must be identified and eliminated so to run system with maximum efficiencies.

II. LITERATURE REVIEW

After studying different research papers and case studies, summarizing them the following conclusion were drawn related to the principle. The case study also helps as a reference to ahead in particular direction.

V. Jose Ananth Vino, Dr. J. Hameed Hussain [1] presented a study on design and analysis of propeller shaft. This paper mainly focuses on increasing the efficiency, moreover faster and precise positioning. High torque and low inertia allows faster positioning times on permanent magnet synchronous servo drives. Feedback sensor directly on rotary part allows precise angular position sensing. The presented work also deals with design optimization i.e. converting two piece drive shaft (Structural steel shaft) in to single piece light weighted composite drive shaft.

Dr. K. Rambabu [2] presented a deep study on the design and optimization of drive shaft with composite materials. The drive shaft of Toyota Qualis was chosen for determining the dimensions, which were examined and checked for the stability of drive shaft is ensured by limiting the include values with in the permissible range in Ansys 12.0

From the paper represented by Raffi Mohammed, K.N.D.Malleswara Rao, Mohammed Khadeeruddin [4] on modeling and analysis of drive shaft assembly they have shortly concluded that by the obtained results it can be conclude that the stresses induced in all the materials are within their allowable limits. And it can also be observed that the materials which develop less von-mises stress exhibit a little more deformation.

The paper represented by P.J. Maljaars, M.L. Kaminski, J.H. den Besten [5] concludes that the this paper presents the FE modelling, a model updating method by means of an MNET and results for two small scale composite propellers. For the FE modelling of the blades an approach to determine the element dependent material orientations in doubly curved geometries has been developed. The advantage of the presented approach is that the in-plane material directions are independent of the orientation of the element itself, in contrast to material orientations aligned to the local element coordinate system. Eigen frequency calculations show a significant difference between results obtained with the material orientations aligned to the local element coordinate system and the presented element dependent material orientations

The concept of throughput time was studied by Raj Mohan R, V.Senthil Kumar [6] which says physical tracking approach is an effective means for improving the productivity and delivery and noted that can make substantial improvement in Throughput time reduction. This result provides convincing evidence that eliminating some non-value added activities like waiting time, idle time, etc., in Gemba leads to a continuous improvement in process.

M. Jeevan Prasad, G. Guru Mahesh and D. Krishna Mohan Raju [7] describes the failure of propeller shaft in their study. In the Bharat Stage-II Tata Busses, the propeller shaft Center Bearing Bracket failures are observed. The Center Bearing Bracket failure is observed mainly at the fillet region .To reduce the stress the dynamic analysis of the propeller shaft transmission system is to be done, to determine the cause of operating conditions which are exerting very high loads on the Bracket.

From the paper represented by R. Warikoo & M. R. Haddara [9] their study suggests analysis of propeller shaft transverse vibrations. Increase in the pitch angle slightly decreases the natural frequency of the blade. Shear deflection and rotary inertia also tend to decrease the natural frequency; effects due to the former are predominant at higher modes.

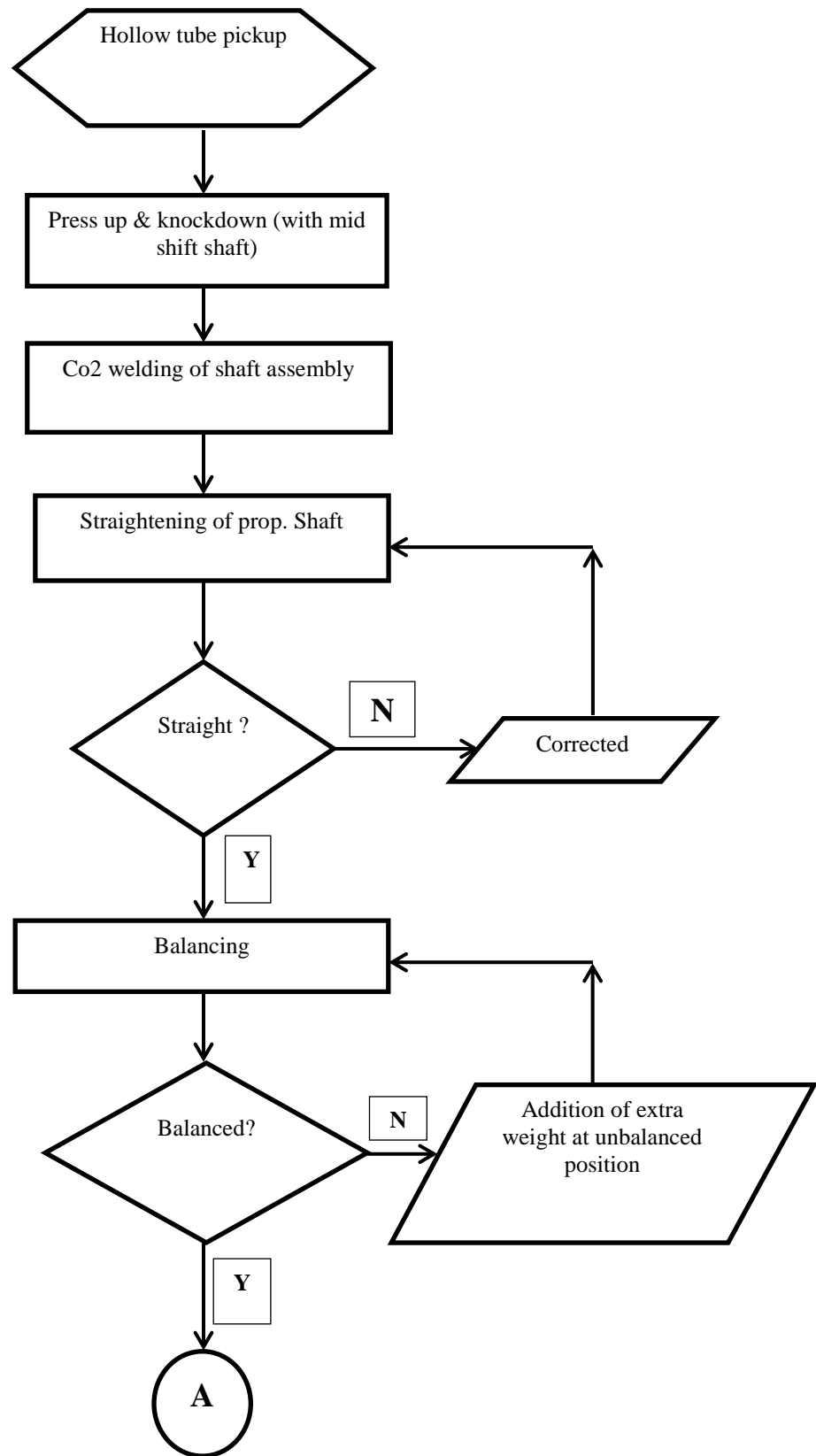
It is equally important to study the causes of failure of the propeller shaft. The reference of the study carried out by the paper represented by M. Jeevan Prasad, G. Guru Mahesh and D. Krishna Mohan Raju n their study regarding [10] “ Failure Analysis of a Center Bearing Bracket Mount of a Propeller Shaft” describes that The Center Bearing Bracket failure is observed mainly at the fillet region. Based on the endurance strength of the existing bracket the maximum stress of 830.49 MPa is observed in the Finite Element Analysis of existing bracket. As the allowable maximum stress is 240 MPa the Finite Element Analysis is carried out for different thicknesses i.e. 6mm, 7mm, 8mm and 9mm. The results show that at 9mm thickness the bracket design is safe because the maximum stress is 227.41 MPa which is less than allowable stress of 240 MPa. The Analysis clearly shows that the stresses applied on the bracket are high mainly due to abused operating conditions. To reduce the stress on the Bracket the dynamic analysis of the propeller shaft transmission system is to be done, to determine the cause of operating conditions which are exerting very high loads on the Bracket.

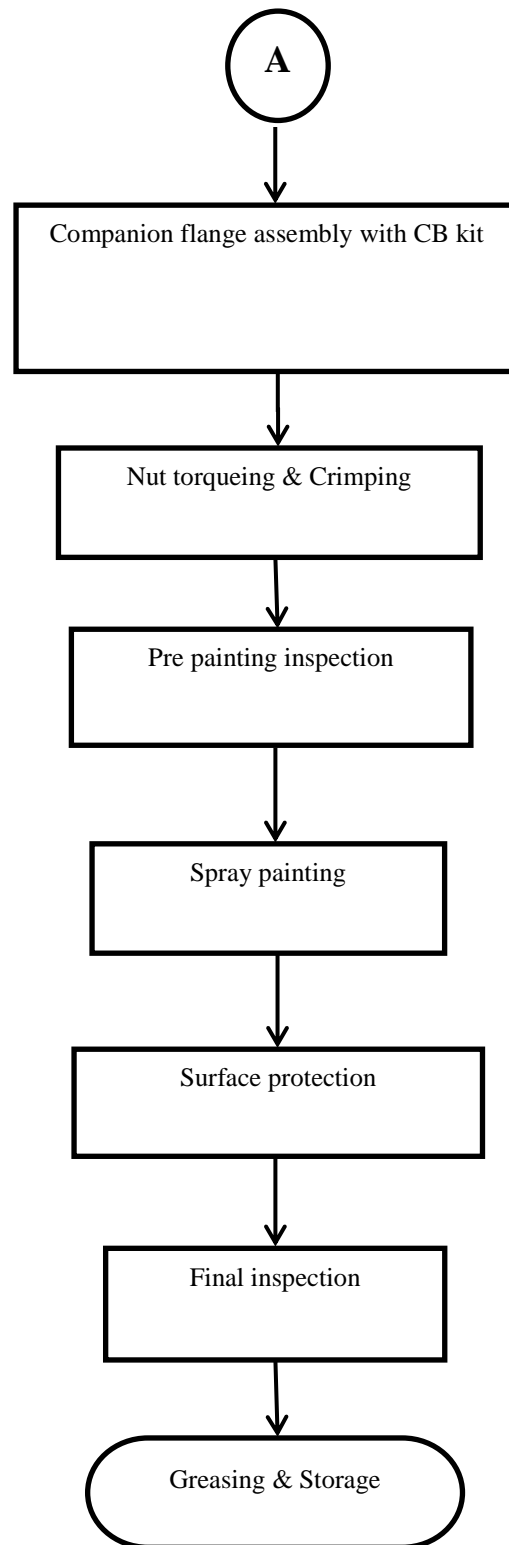
There is a need to automate in order to achieve the desired goals and aspects. The design of fixtures to improve and enhance the production is also important. The study represented by Charles Chikwendu Okpala, Ezeanyim Okechukwu C [11] in their paper “The Design and Need for Jigs and Fixtures in Manufacturing” concludes Jigs and fixtures are manufacturing tools that are employed to produce interchangeable and identical components. They are unique tool-guiding and work-holding devices designed specifically for machining and assembling large number of parts. They eliminate the need for a special set-up for every work-piece thereby facilitating production and also ensuring that every work piece is manufactured within a predetermined tolerance. The design of jigs and fixtures is dependent on the operation type as well as themachine tool to be used for the operation. The paper explained that since the design of jigs and fixtures is dependent on numerous factors which are analyzed to achieve an optimum output that they should be made of rigid light materials to facilitate easy handling.

After scrutinizing the literature & study the following is the objectives and the problem drawn

III. METHODOLOGY

To reduce the throughput time of assembly of propeller shaft we studied the various processes that were carried out in the organisation for assembly of propeller shaft. These processes are given below in flow chart-



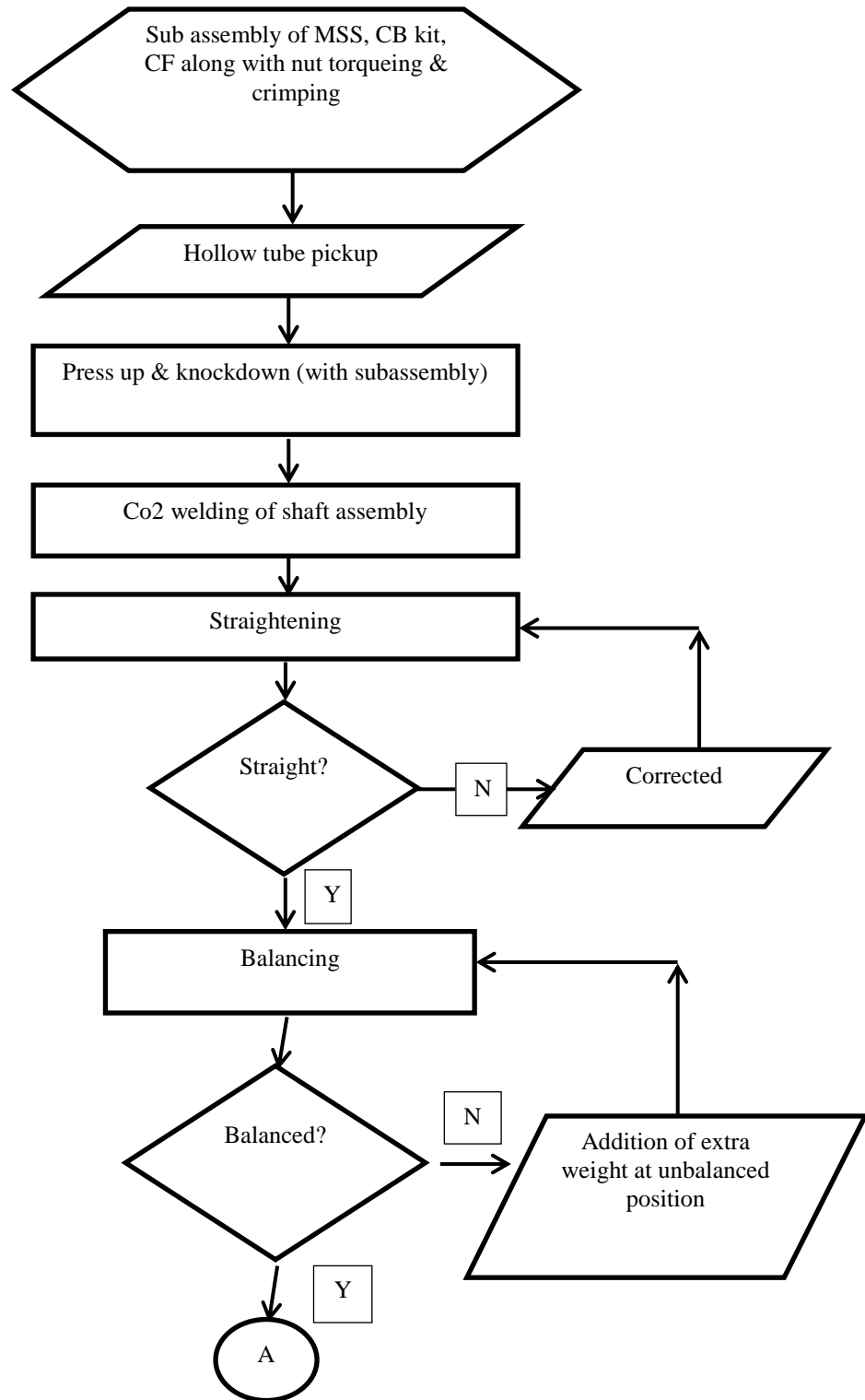


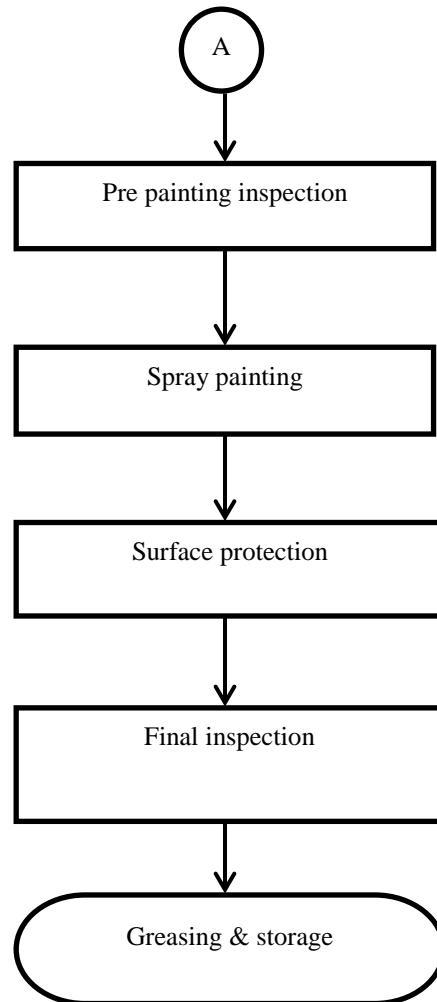
In the above shown flow chart we studied each process and calculated the time required for every process. By observing the process for weeks & evaluating the time consumption of each process it was analysed that the process of Companion Flange & CB kit assembly was the process that was consuming the time unethically. The reason behind this was the conventional way of performing the process manually. Moreover the workforce engaged for this particular process was of 4 workers. 2 worker transfers the shaft and aligns the shaft on the holding machine, then the 3rd worker would be standing on the wooden plank placed beside the machine to assemble the CB kit Companion

Flange. Followed by this the 4th worker would use to torque the nut. This way the process would use to be accomplished.

In order to reduce the production time of propeller shaft we decided to carry out the process of assembly of CB kit, companion flange and mid shift shaft initially before starting the whole processes. This assembly will be done

using hydraulic press followed by nut torquing process. The rest of the process sequence remains the same. The flow chart for modified processes is given below-





In the above modified procedure a holding fixture is required to be designed for preventing the relative motion that will occur when we torque the nut of the subassembly. This motion initiates between the torquing gun and the subassembly. For designing the holding fixture we measured the various parameters of the subassembly like its height, width and considering the ease in process of nut torquing we designed the holding fixture which is shown below-

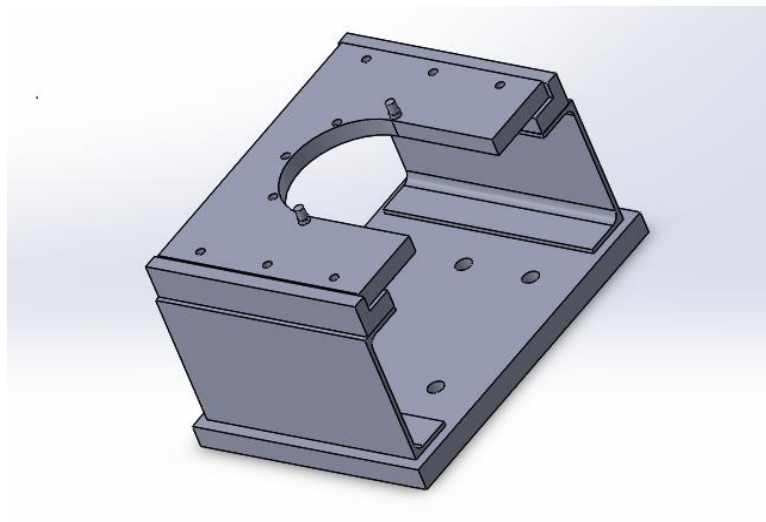


Fig- Holding fixture used in nut torquing process

RESULT: By implementing the above modified procedure and introducing the fixture in nut torquing we obtained a suitable reduction of throughput time in production of propeller shaft. Along with this the required manpower also reduce which results in improving the production rate of the organization. After this quality of product improved, which

ultimately resulted in reduction of in house complaints of the organization along with the customer complaints and increase in life cycle time of the product.

CONCLUSION: The desired objective was completed by few modifications in the design process and by changing the fixture design. The throughput time of propeller shaft was successfully reduced. It concluded with increase in manufacturing and reduction of in-house complaints.

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