

BALANCING THE CRANKSHAFT MACHINING LINE TO IMPROVE THE QUALITY AND OVERALL EFFICIENCY OF PRODUCTION LINE

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ABSTRACT

As the technology is advancing and modifying, the competition among the companies increases and they are eagerly working over the things to just minimize the time bounding to produce a product by introducing and verifying various technical and physical aspects. The companies now days are also proceeding towards the certification from the external bodies to get their best for their customers. In the present case, the component considered is the crank shaft manufactured in one of the companies at Ludhiana, wherein the process there was a time lag and the line was observed not completely balanced. Further, in the present case, the main aim was to use our theoretical aspects as much as possible to shape them up in practical format. Few major findings at the initial stage were observed as Unbalanced line and shortage of the material from POD machining for next operation. The line cycle time observed as 0.17 seconds during POD turning and rest of operations contains approx. 0.12 seconds. The relevant data has been collected and after brainstorming, it has been suggested to introduce new drilling machines for the drills during the POD turning operations. Two new operations for drilling has been suggested in between and it has been observed that the line cycle time for POD turning has reduced to 0.12 seconds from 0.17 seconds. The line has been balanced following such little improvement.

1. INTRODUCTION

1.1 Quality:

Now a day's customer satisfaction is the prime target of every manufacturing industry and the customer satisfaction is obtained from the quality of the product. The conformance to the standards, meeting the expected specification is very important. As in the modern era of technology, the competition is increasing; the quality of the product is very important and needs to be maintained by the manufacturers. Now customer needs must be in accordance with the standards, so that the product can compete at the national as well as international level. Man, machine, material, method etc. are the factors which must equally participate to maintain quality of the product.

Depending upon the requirements and need of the customer, the quality can be maintained, the quality of casting, machining and grinding is comparable but casting, machining and grinding to be used is merely required by the customer [11]. Here it is important to share that the quality of casting must fulfill its standards. Same way the quality of the machining and grinding must fulfill its standards.

It is important to note that the quality of the product must be maintained at comparable prices which are easily accepted by the customer.

Continual improvement in the quality is beneficial both to the customer and the manufacturer. It needs a proper planning and controlling at the acceptable price.

- Quality is basically conformance to the standards.
- Quality is the degree of excellence of the product at acceptable price.
- Quality tells us about the life of the product.
- Quality means to fulfill the promise.

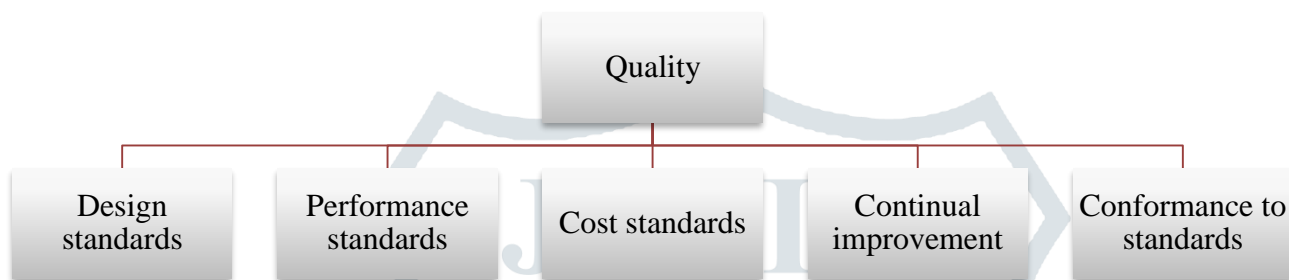


Figure 1 showing the Quality system

Quality of product must be maintained from procurement of raw material, processing, packing, dispatching to the after-sale servicing.

- Design standards relates to the specification of the product. Example 15.985 ± 0.005 . The tolerance on the product, manufacturing process all needs to be controlled and planned accordingly.
- Performance standards include working of the product, its reliability and maintainability. It also decides the life of the product.
- Cost standards relate to conformance to standards acceptable to cost and price. The manufacturing as well as maintaining cost of the product must be worked upon in a manner that quality of product cannot be compromised.
- Continual improvement is a key requirement of any quality control and quality assurance system. It leads to progressive change in the quality system.

1.1.1 Effective Quality Control System

- Quality control is a tool to measure the performance of process and compare with set of standards and taking measures, if required.
- Quality control is a process of comparison of performance of a process with a set of standards and taking measures if there is non-conformance to standards.

Every organization utilizes quality control as a tool to control different factors affecting the quality of the product at economical level. The factors include man, machine, methods, tools, instruments etc.

1.1.2 Objectives of Quality Control

Quality control helps to achieve customer satisfaction with quality product. It helps to increase the profit of the company. It makes to produce products acceptable to the customer. Quality control focus or work to reduce wastage of resources. It aims to reduce the rejection of products with defect and prevents poor products from reaching the customer. It ensures the interchangeability of product with in a controlled cost by bringing the uniformity among products. It works to enhance quality awareness among work organizations and targets to bring confidence about the product among customers. It aims to provide better services of high-quality levels. It suggests corrective actions for rejected goods to reduce the level of rework of rejected goods which in mainly helps to improve or increase the productivity of organization

Quality Control reduces or Eliminates the scrap to increase the profit of the company by establishing set of standards to increase the productivity of the company. Further it prevents defective goods from reaching the customer to increase the sale of the company. Quality control observes and monitors the system to detect the deviations from the set standards, provides high quality level product to increase the reputation of the company. It brings flexibility in the system to achieve continual improvement and ensuring better relationship with customer to achieve the customer satisfaction.

1.1.3 Factors Affecting Quality of Product

The ability of the organization to invest affects the quality of the product. Quality of the product is altered by the commitment of the organization towards quality. The policies and involvement of the management, product design and developments, manufacturing methods, machine tools availability, quality of raw material and tools used, competency skills of labor, product storage methods affect the quality of the product. The feedback from inspection helps to improve quality of the product.

1.2 Operation Management:

Operation Management is basically a decision-making function to achieve customer satisfaction at minimal cost. The decisions involve the decisions associated with the production, maintenance or operations in a system [1-3]. The conceptual operation management system or model includes the input followed by processing and then the required output to achieve customer satisfaction. Operations Management deals with the arrangement and management of things, techniques, organizations and supply chains [5]. It considers the obtainment, headway, and utilization of benefits that associations need to pass on the product and endeavors their clients need. The outfit of OM ranges from imperative to vital and operational levels. Operations Management is the capacity of dealing with the working center of an association: the exercises related with creation, generation, conveyance and conveyance of the association's products and enterprises [10]. The Operations Management Group at IIM Lucknow looks to give Indian associations the information base identifying with this working center, to assist them with getting locally and globally aggressive [8-9]. In particular, the gathering takes a shot at recognizing, creating, reporting, deciphering for training, and dispersing inventive methodologies in

Manufacturing and Supply Chain Management. These methodologies depend on model-based research and blend of best practices from around the globe. The gathering intends to do the accompanying:

- Providing the coaching to dedicated experts.
- Conducting investigation and conferring experiments.
- Inspiring and planning experts for scholastic professions.

Operations management is huge. It is stressed over making the organizations and things whereupon we all in all depend. And all affiliations produce some mix of organizations and things, paying little respect to whether that affiliation is colossal or small, amassing or organization, for advantage or not income driven, open or private. Operations management is in like manner testing. Propelling the imagination which will empower relationship to respond to such a noteworthy number of changes is transforming into the prime task of operations chiefs. It is they who must find the responses for inventive and environmental challenges, the loads to be socially able, the wrinkling globalization of business segments and the problematic to characterize topics management. Operations Management involves in different areas like application of Information and Communication Technologies, Supply Chains, Logistics-Quality, HR-Operations, Manufacturing-Design, Services-Industries, Health-care, Hospital-Operations, Supply Chain Planning in Food Processing Industries, Time studies, work studies and Environment Management.

1.3 Time Study

A time and motion study are a combination of procedures of Time Study and motion study. It is a substantial fragment of logical direction. Method Study involves the study of methods of the process to reduce the work performed to useful work. Work Measurement involves the study and reducing the ineffective time by suggesting effective time for the operations suggested by the method study [22]. The two procedures joined, sophisticated and conceded appropriately into a context. Such incorporated way to deal with work strategies can be applied in organizations like manufacturing or production.

Time and motion study must be utilized together so as to accomplish sane and sensible outcomes. It is especially significant that push to be utilized in motion study to guarantee evenhanded outcomes when time study is utilized. Truth be told, a significant part of the trouble with time study is a consequence of employing it without a careful study of the motion example of the activity. Motion study can be viewed as the establishment for time study. The time study gauges the time needed to play out a given assignment as per a pre-defined technique and is substantial just inasmuch as the strategy is proceeded. When another work technique is built up, the time study must be altered to concur with the new strategy.

Execution estimation is a procedure for gathering and announcing data with respect to the presentation of an individual, gathering or associations. It can include taking a gander at process/systems set up, just as whether results are in accordance with what was planned or ought to have been accomplished.

1.3.1 Work Design:

- Involves the analysis and model of work system in any organization.
- Organized probe of current work systems, suggesting best fit model to satisfy needs and targets.
- Nadler proposed work design assumptions.
- Productivity enhancement and efficacy are prime goals of reviewing work system.
- Work systems studied for improvement and betterment.
- All aspects involved in the system while studying.

1.3.2 Method Study or Work Measurement:

- Both are allied to each other.
- Method Study involves the study of methods of the process to reduce the work performed to useful work.
- Work Measurement involves the study and reducing the ineffective time by suggesting effective time for the operations suggested by the method study.

1.3.3 Work Study:

The primary steps involved in the method study and work measurement are mentioned below:

- Selecting the process
- Recording the data from process
- Examining the process
- Developing the plan for the process
- Measuring and studying for the effectiveness
- Define the process after suggestions
- Installing the new process and note the improvements
- Maintaining the process for betterment.

2. LITERATURE REVIEW:

Operations Management deals with the arrangement and management of things, techniques, organizations and supply chains [5]. It considers the obtainment, headway, and utilization of benefits that associations need to pass on the product and endeavors their clients need. The outfit of OM ranges from imperative to vital and operational levels [6-7]. Operations Management is the capacity of dealing with the working center of an association: the exercises related with creation, generation, conveyance and conveyance of the association's products and enterprises [10]. The Operations Management Group at IIM Lucknow looks to give Indian associations the information base identifying with this working center, to assist them with getting locally and

globally aggressive [8-9]. In particular, the gathering takes a shot at recognizing, creating, reporting, deciphering for training, and dispersing inventive methodologies in Manufacturing and Supply Chain Management [13]. These methodologies depend on model-based research and blend of best practices from around the globe [18]. A time and motion study are a combination of procedures of Time Study and motion study [16]. It is a substantial fragment of logical direction. Method Study involves the study of methods of the process to reduce the work performed to useful work [19]. Work Measurement involves the study and reducing the ineffective time by suggesting effective time for the operations suggested by the method study [22]. The two procedures joined, sophisticated and conceded appropriately into a context. Such incorporated way to deal with work strategies can be applied in organizations like manufacturing or production.

Time and motion study must be utilized together so as to accomplish sane and sensible outcomes. It is especially significant that push to be utilized in motion study to guarantee evenhanded outcomes when time study is utilized [16]. Truth be told, a significant part of the trouble with time study is a consequence of employing it without a careful study of the motion example of the activity. Motion study can be viewed as the establishment for time study [21]. The time study gauges the time needed to play out a given assignment as per a pre-defined technique and is substantial just inasmuch as the strategy is proceeded. When another work technique is built up, the time study must be altered to concur with the new strategy [14]. These methodologies depend on model-based research and blend of best practices from around the globe.

3. PRESENT CASE:

As the technology is advancing and modifying, the competition among the companies increases and they are eagerly working over the things to just minimize the time bounding to producing a product by introducing and verifying various technical and physical aspects. The companies now days are also proceeding towards the certification from the external bodies to get their best for their customers. In the present case, the component considered is the crank shaft manufactured in one of the companies at Ludhiana, wherein the process there was a time lag and the line was observed not completely balanced. Further, in the present case, the main aim was to use our theoretical aspects as much as possible to shape them up in practical format. Few major findings at the initial stage were observed as Unbalanced line and shortage of the material from POD machining for next operation. The line cycle time observed as 0.17 seconds during POD turning and rest of operations contains approx. 0.12 seconds. The relevant data has been collected and after brainstorming, it has been suggested to introduce new drilling machines for the drills during the POD turning operations. Two new operations for drilling has been suggested in between and it has been observed that the line cycle time for POD turning has reduced to 0.12 seconds from 0.17 seconds. The line has been balanced following such little improvement. Few main reasons to consider the same case for study are given as:

- To increase the efficiency of the crankshaft machining line.
- To reduce the defects due to rusting of component.

- To strengthen our knowledge and develop practical approach.
- To develop better control and utilize the resource at maximum.

3.1 Problem Formulation:

In the present case, after studying the process, following problems has been observed in the machining of the crank shaft:

- Shortage of the material for the next operations due to time Lag.
- Unbalanced line due to shortage of the material for next operation.
- Developing of the rust over the piece in the crates.

Operations involved in the machining of the crank shaft:

- Operation-10: Facing and cantering
- Operation-20: JOD turning
- Operation-30: POD Turning
- Operation-40: POD drilling and Boring
- Operation-50: JOD Grinding
- Operation-60: POD Grinding

3.2 Methodology Adopted:

- Select:
 - Selection of the operation to be considered (Crank shaft line)
- Record
 - Collection of data
- Examine
 - Verification of the data available
 - Personal interviews
 - Analysing and discussions
- Develop
 - Derive the useful data
- Measure
 - Consideration of useful data
- Install
 - Installation of the new drilling machines
- Implementation and maintain

3.3 Case Description:

In the present study, there was observed a time lag between the movement of the material for the next operation. The Pin OD turning involved a total of 1.28 seconds of the operation time and as there were 5 machines performing the same operation the line cycle times comes as 0.17 seconds. And next operation is the Drilling and boring on CNC machine which involves 1.03 seconds and as it also been performed on 5 machines, the line cycle time comes as 0.12 seconds as shown in figure 2. So, there is a lag between the operations performed and the sources are not utilized with maximum efficiency and effectively. The components remain in the crates got rusted and which is increasing the cost of quality also. Actually, the time taken for the JOD machining operation is less as compared to the POD machining operation and there occurs excess of material for the next operation, so the material from JOD remains as it and got rusted in the crates. It has been observed that the time study or work measurement performed at the start of the plant was not performed effectively and leading to the time lag. Further, it has been observed that the time consumed on the POD turning involved two operations i.e. vendor marking and drilling the oil hole which are not very critical parameter to the quality and while performing the same on the CNC machine involves a part of useful time. So, it has been suggested to perform these two operations separately on the drilling machines. Table 1 shows the line cycle time for different operation performed during crank shaft machining.

Table 1: Unbalanced crank shaft machining line.

| Operation No. | Operation | Machining Time | Loading Time | Unloading Time | Total Time | No. of Machines | Line Cycle Time |
|---------------|---------------------|----------------|--------------|----------------|------------|-----------------|-----------------|
| 10 | Facing & Centering | 0:08 | 0:10 | 0:08 | 0:26 | 2 | 0:13 |
| 20 | JOD Turning | 0:45 | 0:08 | 0:10 | 1:03 | 5 | 0:12 |
| 30 | Pin OD Turning | 1:10 | 0:08 | 0:10 | 1:28 | 5 | 0:17 |
| 40 | Drilling and Boring | 0:45 | 0:08 | 0:10 | 1:03 | 5 | 0:12 |
| 50 | JOD Grinding | 0:11 | 0:02 | 0:00 | 0:13 | 1 | 0:13 |
| 60 | Pin OD Grinding | 0:11 | 0:02 | 0:00 | 0:13 | 1 | 0:13 |

The comparisons of the line cycle time of the unbalanced line are shown in the figure 2.

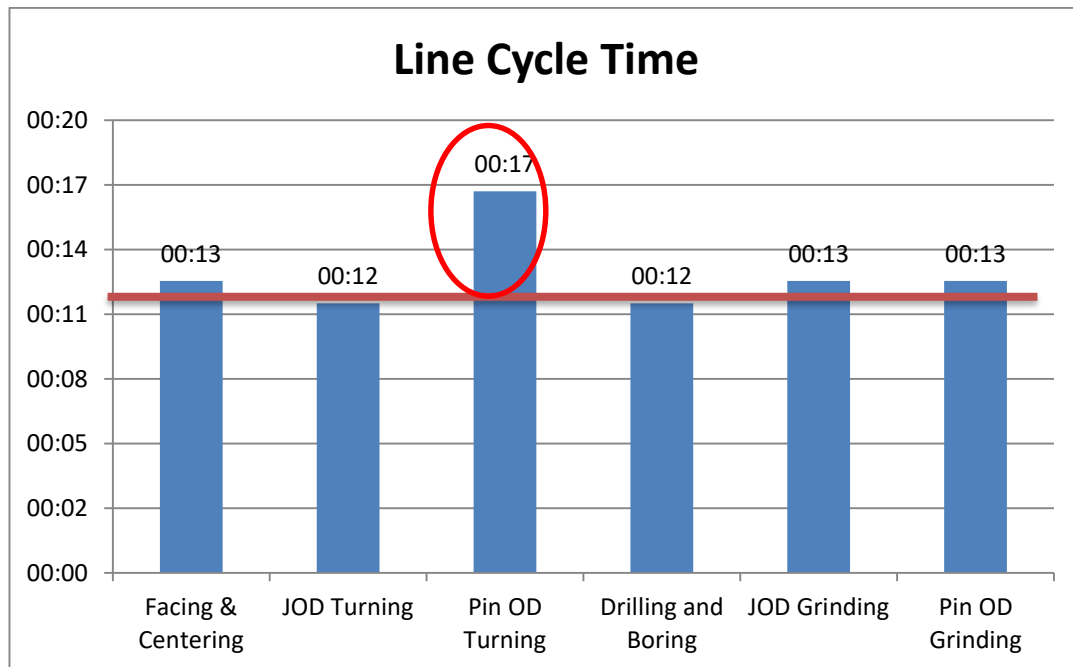


Figure 2: Comparison of the operation performed (Unbalanced line)

A detailed brainstorming has been performed to address the problem of the rusting in the crank shaft. A cause and effect diagram have been plotted to find the main reason as shown in figure 3. The main reason comes as there is a time lag between the operations as the line is not balanced and the component got rusted.

Analysis of Problem:

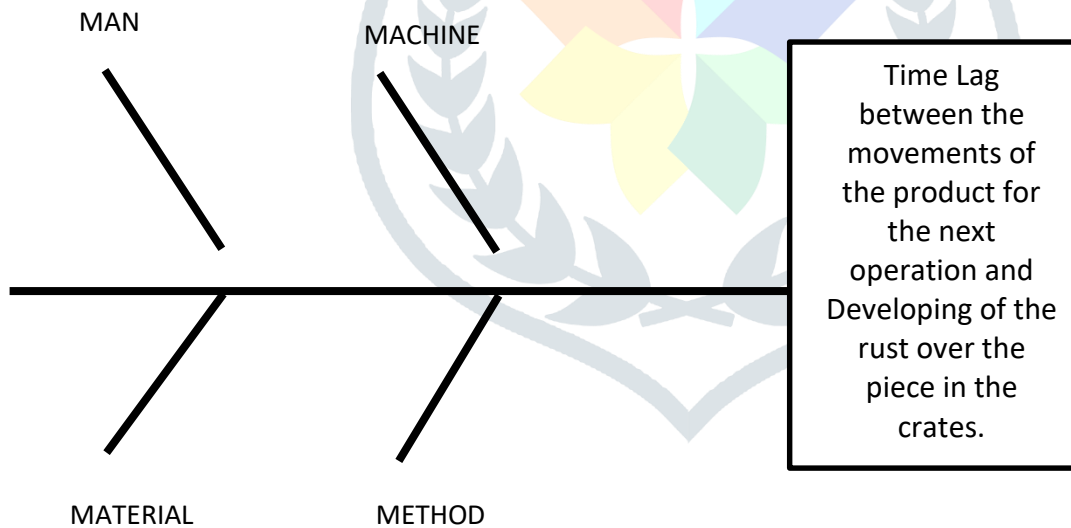


Figure 3: Cause and effect diagram for the rusting problem.

Man:

- Untrained worker
- Newly recruited worker

Machine:

- Time lag between two operation on different machine

Material:

- Material may be hard and poor casting
- Lack of availability of raw material at Operation 10 and 20.
- Non availability of cutting tools.

Method:

- Wrong method adopted.

So, it has been suggested to reduce the time of the POD turning operation. It has been suggested to perform the vendor marking and oil drill on separate drilling machine. The design department has been involved and new fixtures to perform the above-mentioned operations has been designed. It has been recommended that the said operations can be performed before final grinding operations as they are not affecting any other in between operation. After implementing the suggested, the case is again observed and the changes observed are shown in the table 2, which is a balanced line.

Table 2: Balanced crank shaft machining line.

| Operations No. | Operations | Machining Time | Loading Time | Unloading Time | Total Time | No. of Machines | Line Cycle Time |
|----------------|---------------------|----------------|--------------|----------------|------------|-----------------|-----------------|
| 10 | Facing & Centering | 0:08 | 0:10 | 0:08 | 0:26 | 2 | 0:13 |
| 20 | JOD Turning | 0:45 | 0:08 | 0:10 | 1:03 | 5 | 0:12 |
| 30 | Pin OD Turning | 0:45 | 0:08 | 0:10 | 1:03 | 5 | 0:12 |
| 30-A | Pin OD Drilling-I | 0:10 | 0:12 | 0:10 | 0:32 | 3 | 0:10 |
| 30-B | Pin OD Drilling-II | 0:12 | 0:12 | 0:10 | 0:34 | 3 | 0:11 |
| 40 | Drilling and Boring | 0:45 | 0:08 | 0:10 | 1:03 | 5 | 0:12 |
| 50 | JOD Grinding | 0:11 | 0:02 | 0:00 | 0:13 | 1 | 0:13 |
| 60 | Pin OD Grinding | 0:11 | 0:02 | 0:00 | 0:13 | 1 | 0:13 |

The line cycle time has been reduced from 0.17 to 0.12 seconds for the POD turning operation on the CNC machine as shown in figure 4.

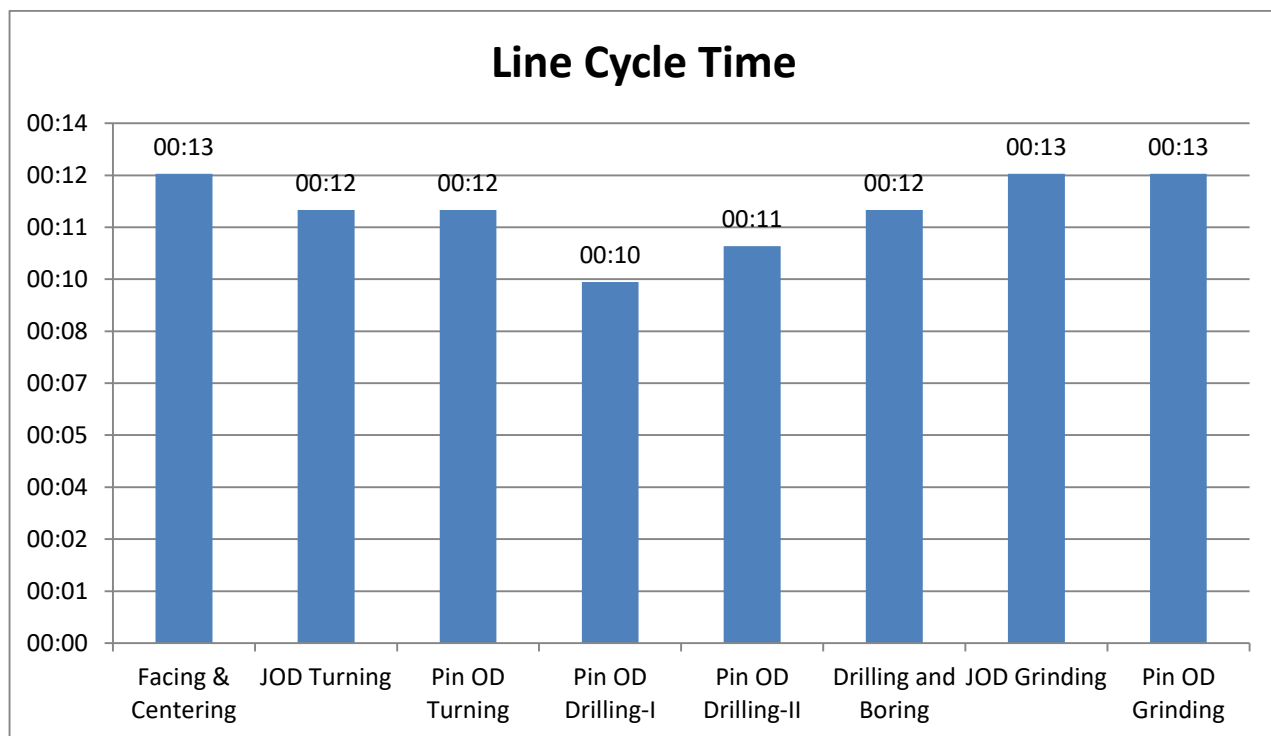


Figure 4: Comparison of the operation performed (Balanced line)

4. **CONCLUSION AND RESULTS:** After implementing the suggested changes, new operations for vendor marking and oil hole drilling have started to perform on the drilling machines separately by using the suitable fixtures. The following conclusions has been observed:

- The time lag between two operations has been reduced and the efficiency of the line improves.
- The quality of the component improves as the problem associated with the rust has been eliminated.
- The wastage of the sources included in the rework of the component has been reduced.
- The sources available are utilized to the maximum extent with more effectiveness.
- The vendor rating improves as the level of customer satisfaction improves.

Such studies can be easily involved in the manufacturing industries and production line. It involves a limitation that it is difficult to collect the real time data in the industries and human error may affect the results.

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