

A Project Report
Submitted
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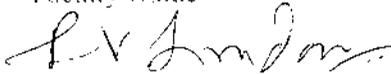
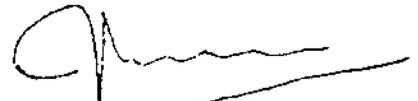
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BONAFIDE CERTIFICATE

Certified that this project report titled "**A Time study on assembly of pumps in Mahendra submersible pumps- Coimbatore**" is the bonafide work of **Mr. G. GOKUL**, Reg No: **1020400018** who carried out the project under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

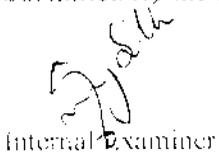
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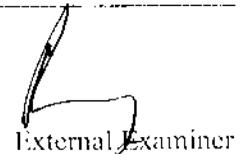
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CHAPTER I
INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION TO THE STUDY:

As we approach the new millennium, with a widely expanded market and manufacturing capability around the world, both the opportunities and the need for technical competence are growing dramatically. According to Niebel (1993), a decade ago the competition was centered in only a few industries - electronics and automotives in particular. But today this competition is both industry wide and worldwide. Each department of these organizations is increasing the intensity of its cost reduction and quality improvement effort in order to survive and expanding. Some companies have even expanded their motion and time study method to nonmanufacturing activities with the rise in the importance of indirect factory labor.

One of the oldest tools used by industrial engineers in work measurements is time study and specifically stopwatch time study. Time study that originated by Taylor and developed by Gilbreths was used mainly for determining time standards and motion study. According to Rice (1977), over 89 percents of the companies that perform work measurement used time study. The technologies are rapidly growing everyday but there are still no tools that can replace time study method completely. They only invented equipment that can improved the tools and made it users friendly. According to Niebel (1993), computers produce standards from fundamental motion data up to 50 percents faster than manual methods. The computers also provides a simple and convenient way to make time studies, monitor and measure machine and equipment performance, make work sampling studies, and perform other data-gathering activities. Even though there are many techniques and equipments to perform the time study, but basically the concept is just the same.

In this study, we are going to go through such a company, which was able to put aside the obstacles put in front of it. The Mahendra Submersible Pumps (P) Ltd was able to make it possible by quickly adopting to changing scenario.

1.2 INDUSTRY ANALYSIS:

Mahendra group is represented by a number of companies in various domains. The first company to be formed was Mahendra Pumps (P) Ltd . They started the production of agricultural pumps & motors. Then came the inception of Mahee Engineering (P) Ltd Unit - I. Instituted in 1973, it deals with the manufacturing of pumps for portable engines. In 1977 Marvel Engineering Industries was established. This unit is involved with the manufacture of domestic pumps & single-phase pumps for agricultural application.

In 1985, Mahendra Submersible Pumps (P) Ltd dealing with the manufacturing of Submersible pumps & Jet pumps for domestic & agricultural application was founded. The institution of Mahendra Spinning Mills Pvt. Ltd. in 1991 marked the extension of Mahendra group's expertise in the textile domain. This unit deals with the production of Cotton Yarn. The Mahee Engineering (P) Ltd Unit - II, established in 1996 deals with the Manufacture of Bore-well compressor pumps.

1.3 COMPANY PROFILE:

1.3.1 Company Name: Mahendra Submersible Pumps (P) Ltd

1.3.2 Company Logo:



1.3.3 Company Website: www.mahendrapumps.in

1.3.4 History:

Mahendra pumps was established in the year 1960 in Coimbatore, today Mahendra Pumps is a well known name for superior quality pump sets worldwide. The company manufactures about 750 varieties of pumps for domestic, industrial and agricultural needs.

The credit of achieving ISO 9001:2000 accreditations from BVQI, London for the very first time in South India also goes to Mahendra Pumps.

The Company is always keen to deliver superior, innovative solutions that suits to the specific needs of the customers by utilizing its fully mechanized and automated foundry with state-of-the-art technology. As the world talks about energy saving and efficiency, Mahendra pumps have already launched, state-of-the-art - Five Star rated Energy Efficient pumps in various models for agriculture, domestic as well for industrial purposes. It is one way of Mahendra's commitment towards the Green Earth.

Moreover Mahendra also adheres to high safety standards and is accredited with the universally accepted CE marking for single phase Monoblocs and Submersible pumps. With a strong dealer and sales network, sales and after sales service requirements are met on time and are professionally conducted.

For many decades, the company has been exporting to countries like South Africa, Sri Lanka, Bahrain, UAE, Vietnam, Australia, Qatar and Egypt for several years .

1.3.5 Product Variants:

1. Centrifugal Monobloc Pumps
2. Open Well Submersible Pumps
3. 200 MM (8") Bore well Submersible Pump sets
4. 150 MM (6") Bore well Submersible Pump sets
5. 100 MM (4") Bore well Submersible Pump sets
6. Jet Centrifugal Monobloc Pumps
7. Bore well Compressor Pumps
8. Domestic Monobloc Pumps

1.4 STATEMENT OF PROBLEM:

Mahendra Submersible Pumps (P) Ltd used Time Study for two main purposes, one for bidding new projects and the other one is to monitor the manufacturing or production of current projects. The current project needs to be monitor by using time study in order to control the cycle time and labor power of one project. Another point why time study suited with Mahendra Submersible Pumps (P) Ltd because 90 percents of the production in this company is manual basis so there's no better tool to measure the work than time study because it include the rating factor and allowances. In the mean time it also can be use as a tool for productivity improvement and increase efficiency. Since time study is so important for the company, it had to be done precisely with the element of allowance, rating factor and head count to produce a standard time which can be used as reference to conclude the whole performance of production.

1.5 OBJECTIVES :

1.5.1 Primary Objective:

- (i) To calculate the Standard Time required to carry out the activities for assembling a pump.
- (ii) To propose areas of improvement that may help to reduce the time taken to complete the work.
- (iii) To measure the performance of workers.

1.5.2 Secondary Objective:

- (i) To provide a basis for setting piece rate or incentive wages.
- (ii) To determine the number of machine tools an operator can handle.

1.6 SCOPE OF THE STUDY:

To ensure the objectives will successfully achieve, there are several element that need to be followed as well:

- (i) Conduct a time study by including cycle time from observation with the allowance and rating factors to produce standard time.
- (ii) The study was undertaken by using stopwatch time study technique.

CHAPTER II
REVIEW OF LITERATURE

REVIEW OF LITERATURE

Sarker, Bhaba R.Harris, Roy D (1988)¹ Ideally a production line is perfectly balanced and most efficient when all the stages have been allocated an equal amount of task times. but realistically this situation is almost impossible for a practical problem. For such an ideal situation, the just-in-time (pull system) production system holds no inventory in between the stages, such that the production process is just-in-time. The stage operation times are random variables and the mean of each operation time has been assumed deterministic in sampling from a group of different mean operation times. Thus, because of the differences in stage operation times due to the variability of the operator's performance and/or unequal distribution of task times, the production line experiences various types of problems. In this paper we tried to see the effects of this imbalance of stage operation times in a just-in-time (JIT) production system.

Manikas, Andrew ,Chang, Yih-Long (2009)² Scheduling jobs on multiple machines is a difficult problem when real-world constraints such as the sequence setup time, setup times for jobs and multiple criteria are used for solution goodness. It is usually sufficient to obtain a near-optimal solution quickly when an optimal solution would require days or weeks of computation. Common scheduling heuristics such as Shortest Processing Time can be used to obtain a feasible schedule quickly, but are not designed for multiple simultaneous objectives. We use a new meta-heuristic known as a scatter search (SS) to solve these types of job shop scheduling problems. The results are compared with solutions obtained by common heuristics, a tabu search, simulated

¹ International Journal of Production Research; Jan1988, Vol. 26 Issue 1, p1, 18p

² International Journal of Production Research; Sep2009, Vol. 47 Issue 18, p5217-5236, 20p, 1 Diagram, 6 Charts, 2 Graphs

annealing, and a genetic algorithm. We show that by combining the mechanism of diversification and intensification, SS produces excellent results in a very reasonable computation time. The study presents an efficient alternative for companies with a complicated scheduling and production situation.

Ko, Chang Seong , Cha, Myung Soo Rho, Jae Jeung (2007)³, This study presents two approaches for determining standard time in a multi-pattern and short life-cycle production system. We explain the approaches through conducting a case study on a tableware manufacturing company, gathering field data on the company that represent the characteristics of the multi-pattern and short life-cycle production system. In the first approach, based on the production field data, new weights for each variable in function and difficulty grade categories are estimated and corresponding model for determining standard time is developed. In the second approach, the standard time is determined based on the existing weights for each variable in two categories. Multiple regression models are developed for each approach. Based on standard time data, a conversion table reflecting the comprehensive difficulty is generated and used for differentiating the items produced by each worker.

Ge, Y , Yih, Y (1995)⁴ This paper studies a crane scheduling problem with time windows in a flow-shop type production system. Feasibility of a state of the system is first discussed. Then, based on the insight derived from the mathematical programming formulation of feasibility, an optimization-based heuristic algorithm for real-time scheduling of the system is developed. Computer simulation on randomly generated problems shows that this algorithm has an excellent performance in maximizing throughput without defective jobs.

³ Computers & Industrial Engineering; Sep2007, Vol. 53 Issue 2, p321-325, 5p

⁴ International Journal of Production Research; May95, Vol. 33 Issue 5, p1187, 13p

Copas, Cathal, Browne, Jim (1990)⁵ The scheduling system described in this paper is to be used for the short-term planning and control of assembly systems at the production activity control (PAC) level. PAC operates as close to real-time as possible, and therefore the scheduling system has to be capable of analysing the manufacturing system and generating a schedule in a short time frame. Because of this time constraint, traditional scheduling techniques such as branch and bound, dynamic programming, etc., are inappropriate. The approach taken in this scheduling system is to combine heuristic rules with newly developed artificial intelligence (AI) techniques while incorporating insights into scheduling gained from a study of the just-in-time, optimized production technology and manufacturing resource planning (MRP II) approaches to production management. The resulting scheduling system is presented, and its implementation on a MicroVAX workstation using data from an electronics assembly facility is described.

Nicholson, T. A. J , Pullen, R. D (1971)⁶ This paper describes a general model for planning work flow through a multi-process production system and proposes a new practical scheme of control for scheduling. The features of the model are based on experience of a wide variety of industries and a means is considered for resolving the conflicts between different objectives such as meeting due dates and reducing work in progress. The control system presumes that only the inlet times of the jobs into the production system can actually be decided and managed by a production planner, and not the subsequent internal operation start times, as previous studies have often assumed. A method for optimizing the schedule is developed on the basis of this form of control and it is illustrated on a small example. Finally implementation factors and extensions are discussed.

⁵ International Journal of Production Research; May90, Vol. 28 Issue 5, p981, 25p

⁶ International Journal of Production Research; Apr71, Vol. 9 Issue 2, p219, 9p

CHAPTER III
RESEARCH METHODOLOGY

CHAPTER 3

RESEARCH METHODOLOGY

3.1 RESEARCH DESIGN:

The Research design is the conceptual structure within which the research is conducted. **Descriptive research** studies are concerned with describing the characteristics of particular individual or a group. This design aims at securing accuracy by minimizing bias and maximizing reliability of data collected. **The Descriptive Research design** helps to study and investigate into greater details to make a time study on Assembly of pumps in Mahindra Submersible Pumps, Coimbatore.

The descriptive Research design focuses attention on the following:

- Formulating the objective of the study
- Designing the methods of data collection
- Selecting the sample
- Collecting the data
- Processing and analyzing the data
- Reporting the findings

3.2 DATA AND SOURCES OF DATA:

The primary data was collected through **Time Study Form**. It collects data about the observed time for each process repeatedly through which Total Observed time, Average observed time, Normal Time and Standard Time can be measured for each process. The data collected was coded and for better understanding of subject, it was summarised using Tables and charts.

3.3 TIME PERIOD COVERED:

The total time period of the study was 45 days and the data collection was carried out in 15 days.

3.4 POPULATION AND SAMPLE SIZE:

A sample is a part of whole universe being taken for the study. The sample represents the whole universe. The total number of employees involved in manufacturing of Mono Bloc Pumps is 9 among the 20 workers in the organization and hence the sample size is 9.

3.5 SAMPLING TECHNIQUE:

Since the study is descriptive in nature it was found to apply the census sampling method. The study was done in Mahendra Submersible Pumps (P) Ltd which works for contract manufacturing. The time study is for the manufacturing of Mono Block Pumps and hence the entire population of 9 is taken as sample of observance to increase the accuracy of the study.

3.6 RESEARCH TOOLS USED:

3.6.1 Time study equipments

The equipment needed for time study work consists of a timing device and an observation board. The devices most commonly used for measuring work area.

- (i) Observation board
- (ii) Stopwatch
- (iii) Time study forms

3.6.2 Making the time study

The exact procedure used in making the time studies may vary somewhat, depending upon the type of operation being studied and the application that is to be made of the data obtained. These eight steps, however, are usually required to perform time study in industries.

- (i) Divide the operation into elements and record a complete description of the method
- (ii) Observe and record the time taken by the operator
- (iii) Determine the number of cycle to be timed
- (iv) Rate the operator's performance
- (v) Determine the allowances
- (vi) Determine the time standard for the operation.

3.6.4 Stopwatch Time Study

The actual conduct of a time study is both an art and a science. To ensure success, analyst must be able to inspire confidence in, exercise judgment and develop a personable approach to everyone with whom they come in contact. In addition, their backgrounds and training should prepare them to understand thoroughly and perform the various functions related to the study. These elements include selecting the operator, analyzing the job and breaking it down into its elements, recording the elapsed elemental values, performance rating the operation, assigning appropriate allowance and working up the study itself. There are two standard ways to record time study data. The use of either method is a matter of analyst preference or company practice. The job must be divided into elements before choosing the method. These two methods are:

(i) The continuous method

The data collection of this method involves starting the stopwatch when the study begins and allowing it to run, uninterrupted, until the study is complete. At the conclusion of each element, the current reading, or the elapse time, is recorded on the data sheet. The continuous method is also better adapted to measuring and recording very short elements.

(ii) The snapback method

In this method, after the watch is read at breakpoint of each element. The watch time is returned to zero. As the next element takes place, the time increments from zero. A drawback to using the snapback method is the time that elapses while the hand sweep hand returns to zero. The snapback method is also better adapted to measuring and recording long elements.

3.6.5 Rating, Leveling and Normalizing

Rating is the process of adjusting the time taken by an individual operator to what could be expected from a normal operator. The method was developed by Mundel and Danner, eliminates the difficulty of establishing a normal speed criterion for every type of work. Rating is a matter of judgment on the part of the time study analyst, and unfortunately there is no way to establish a time standard for an operation without having the judgment of the analyst.

Westinghouse System of Rating This method considers four factors in evaluating the performance of operator: skill, effort, conditions, and consistency. Skill may be defined as the proficiency at of an individual in following the given method. It is demonstrated by co-ordination of mind and hands. A person's skill in a given operation increases with his experience on the job, because increased familiarity with work brings speed, smoothness of motions and freedom from hesitations. The Westinghouse system lists six classes of each factor. The time study person evaluates the skill displayed by the operator. And puts it in one of the six classes and also decides the degree in that class, higher or lower, i.e. 1 or 2. As equivalent % value of each class of skill is provided in the Table, the rating is translated into its equivalent percentage value, which ranges from +15 % (for super skill of higher degree) to -22 % (for poor skill of lower degree). In a similar fashion, the ratings for effort, conditions, and consistency are given using the Table for each of the factors. By algebraically combining the ratings with respect to each of the four factors, the final performance-rating factor is estimated. By using Westinghouse Rating System we can calculate the skill, consistency, efforts, condition.

(i) Skill Rating

The effect of skill is minimized by timing only people who are skilled. Operators must be fully trained in their work classification before being time-studied. Habits of motion patterns must be routine enough that the operator doesn't have to think about what comes next and where everything is located. Very skilled operators make a job look easy, and the industrial technologist must let this skill affect the rating.

Table3.2**Westinghouse table**

Westinghouse Skill Ratings		
Skill level	Class	Rating
Super skill	A1	+0.15
Super Skill	A2	+0.13
Excellent	B1	+0.11
Excellent	B2	+0.08
Good	C1	+0.06
Good	C2	+0.03
Average	D	0.00
Fair	E1	-0.05
Fair	E2	-0.10
Poor	F1	-0.16
Poor	F2	-0.22

(ii) Consistency Rating

Consistency is the greatest indication of skill. The operator is consistent when he or she runs the elements of the job in the same time, cycle after cycle. Consistency is used to determine the number of cycles.

A consistent operator needs to run only a few parts before the cycle time is known with accuracy. The skill of the operator should be evident to the time study technician, and the technician's rating of the operator should be high.

Table3.3

Westinghouse table

Westinghouse Consistency Ratings		
Consistency level	Class	Rating
Perfect	A	+0.04
Excellent	B	+0.03
Good	C	+0.01
Average	D	0.00
Fair	E	-0.02
Poor	F	-0.04

(iii) Condition Rating

Working conditions can affect the performance of an operator. In the early twentieth century, this was much more of a problem than it is today. The way we account for poor working conditions today is to increase the allowance. Working conditions are not part of modern rating.

Table3.4**Westinghouse table**

Westinghouse Condition Ratings		
Condition level	Class	Rating
Ideal	A	+0.06
Excellent	B	+0.04
Good	C	-0.02
Average	D	0.00
Fair	E	-0.03
Poor	F	-0.07

(iv) Effort Rating

Effort is the most important factor in rating. Effort is the operator's speed and/or tempo and is measured based on the normal operator working at 100 percents. Psychology has been good to the time study technicians. The normal tendency of people being watched is to speed up. Being watched makes people nervous, and nervous energy is converted by the body into a faster tempo.

The time study technician then gets a frequent chance to rate over 100 percent. When an operator works at 120 percent, the technologist can give the operator 20 percent more time so that an average person can do the job.

Table3.5

Westinghouse table

Westinghouse Effort Ratings		
Effort level	Class	Rating
Excessive	A1	+0.13
Excessive	A2	+0.12
Excellent	B1	+0.10
Excellent	B2	+0.08
Good	C1	+0.05
Good	C2	+0.02
Average	D	0.00
Fair	E1	-0.04
Fair	E2	-0.08
Poor	F1	-0.12
Poor	F2	-0.17

3.6.6 Rating Applications

The first and most important characteristic of any rating system is accuracy. Since the majority of rating techniques rely on the judgment of the time study observer, perfect consistency in rating is impossible. A rating system that is simple, concise, easily explained, and keyed to well-established benchmarks is more successful than a complex rating system requiring involved adjusting factors and computational techniques that confuse the average shop employee. The value of rating is written in the RF column of the time study form. The value of normal time can be calculated by using rating performance from the formula below.

Normal Time:

$$NT = (OT \times PR) / 100$$

Where : OT = Observed Time

NT = Normal Time

R = Performance Rating.

3.2.1 Allowance

Allowances are extra time added to the normal time to make the time standard practical and attainable. No manager or supervisor expects employees to work every minute of the hour.

(i) Personal

Personal allowances is that time an employee is allowed for personal things such as talking to friends about non-work subjects, going to the toilet, getting a drink, going to pray or any other operator-controlled reason for not working. An appropriate amount of time has been defined as about 5 percent of the work day, or 24 minutes per day.

(ii) Fatigue

Fatigue allowance is the time an employee is allowed for recuperation from fatigue. Fatigue allowance time is given to employees in the form of work breaks, more commonly known as coffee breaks. Breaks occur at varying intervals and are of varying duration, but all

breaks are designed to allow employees to recuperate from on-the-job fatigue. Most employees today have very little physical drudgery involved with their jobs, but mental fatigue is just tiring. If an employee uses less than ten pounds of effort during the operation of his job, then five percent fatigue allowance is normal. A five percent increase in fatigue allowance is given for every ten pound increase in exertion required of the employee. The breaks are calculated into the fatigue allowance because the reporting practice is to not report the time spent on breaks separately. Because lunch time is punched out and not reported, it does not enter into the allowance calculation. Allowance is for times when the employees is expected to perform but can't.

(iii) Delay

Delay allowances are called unavoidable because they are out of the operator's control. Something happens to prevent the operator from working. The reason must be known and the cost accounted for to develop the cost justification. The operator's performance must not be penalized for problems out of his or her control. Three methods are available to account for and to control unavoidable delays:

- Add delay allowances to the standard
- Time-study them and add them to the time standard
- Charge the time to an indirect charge.

A three percent allowance will be added to the personal allowance of five percent plus a fatigue allowance of five percent to produce a 13 percent total allowance. An unavoidable delay is a foreign element that cannot be anticipated will require the operator to charge his or her time to indirect account. Supervisors will be required to approve all indirect charges and the time should be more than six minutes to be statistically significant.

Anything that cannot be live with is not supposed to be in the time standard because it is difficult to get it out once it included.

3.6.7 Allowances Application

The fundamental purpose of all allowances is to add enough time to normal production to enable the average worker to meet the standard when performing at standard performance. There are two ways of applying allowances. The most common is to add a percentage of the productive time only. It is also customary to express the allowance as a multiplier, so that the normal time (NT) can be readily adjusted to the standard time (ST).

Allowances:

$$ST = NT / (1 - \text{Allowance})$$

where : ST = Standard Time

NT = Normal Time

3.7 LIMITATIONS OF THE STUDY

- Since the employees are aware that they are being observed, their work credibility varied from other situations.
- While collecting the review the researcher faced difficulties in tracing out an appropriate source.
- Finally due to time constraints, The time study is done only for the manufacturing of Mono Bloc Pump leaving the other products being manufactured in the organization.

CHAPTER IV
ANALYSIS AND INTERPRETATION

CHAPTER 4

ANALYSIS AND INTERPRETATION

DATA COLLECTION

The data was collected from the station (work area) where the study is being conducted. The data was collected using the **Time Study Form** with the help of a stop watch and the entries were made in the form. The entered data is given in the Table.

DATA ANALYSIS:

4.1 Performance Rating Calculation:

By using Westinghouse Rating System we can calculate the workers skill level, consistency level, efforts level, condition level.

Table 4.1

Performance Rating Calculation (PUMP)

Person – 1

LEVELS	CLASS	RATING
Skill level - Good	C2	+0.03
Effort level - Good	C2	+0.02
Condition level - Excellent	B	+0.04
Consistency level - Fair	E	-0.02
		1
TOTAL		1.07

Table 4.2

Performance Rating Calculation (ROTOR)

Person – 1

LEVELS	CLASS	RATING
Skill level - Excellent	B1	+0.11
Effort level - Good	C2	+0.02
Condition level - Good	C	+0.02
Consistency level - Average	D	0.00
		1
TOTAL		1.15

Table 4.3

Performance Rating Calculation (MOTOR)

Person – 1

LEVELS	CLASS	RATING
Skill level - Good	C1	+0.06
Effort level - Good	C2	+0.02
Condition level - Excellent	B	+0.04
Consistency level - Fair	E	-0.02
		1
TOTAL		1.10

Table 4.4 a**Performance Rating Calculation (WINDING & TESTING)****Person – 1****Process:1 to 17**

LEVELS	CLASS	RATING
Skill level - Good	C2	+0.03
Effort level - Average	D	0.00
Condition level - Excellent	B	+0.04
Consistency level - Average	D	0.00
		1
TOTAL		1.07

Table 4.4 b**Performance Rating Calculation****Person – 1****Process - 18**

LEVELS	CLASS	RATING
Skill level - Excellent	B1	+0.11
Effort level - Good	C2	+0.02
Condition level - Excellent	B	+0.04
Consistency level - Good	C	+0.01
		1
TOTAL		1.18

Table 4.5**Performance Rating Calculation (FINISHING)****Person – 1****Process:1,2,3**

LEVELS	CLASS	RATING
Skill level - Excellent	B1	+0.11
Effort level - Good	C2	+0.02
Condition level - Excellent	B	+0.04
Consistency level - Average	D	0.00
		1
TOTAL		1.17

Table 4.6**Performance Rating Calculation (process 4,5,6)****Person – 1****Process:4,5,6**

LEVELS	CLASS	RATING
Skill level - Good	C1	+0.06
Effort level - Excellent	B1	+0.10
Condition level - Good	C	+0.02
Consistency level - Average	D	0.00
		1
TOTAL		1.18

Table 4.7**Performance Rating Calculation (process: 7)****Person – 1****Process:7**

LEVELS	CLASS	RATING
Skill level - Excellent	B1	+0.11
Effort level - Good	C2	+0.02
Condition level - Good	C	+0.02
Consistency level - Excellent	B	+0.03
		1
TOTAL		1.18

Table 4.8**Performance Rating Calculation (process 8)****Person – 1****Process:8**

LEVELS	CLASS	RATING
Skill level - Excellent	B1	+0.11
Effort level - Good	C2	+0.02
Condition level - Good	C	+0.02
Consistency level - Excellent	B	+0.03
		1
TOTAL		1.18

4.2 BAR CHART REPRESENTATION FOR SECTION WISE OPERATION

Before finishing of pump it goes through various section, each section has various activities. Each activities have different observed times. bar chart representation is to analyze which activity take maximum time in particular section. So that remedy actions are taken on particular activity.

4.2.1 Pump assembling:

Process for pump assembling section:

Process 1: Place suction housing on stand

Process 2: Assemble shaft and keep

Process 3: Load on stand

Process 4: Assemble sleeve (30mm)

Process 5: Assemble key on up and down

Process 6: Assemble middle bearing suction

Process 7: Assemble impeller

Process 8: Size checking for every stage

Process 9: Assemble top casing

Process 10: Trust plate

Process 11: Assemble sleeve (27mm)

Process 12: Manually tighten with 2 nuts

Process 13: Assemble top middle case

Process 14: Assemble tube ring

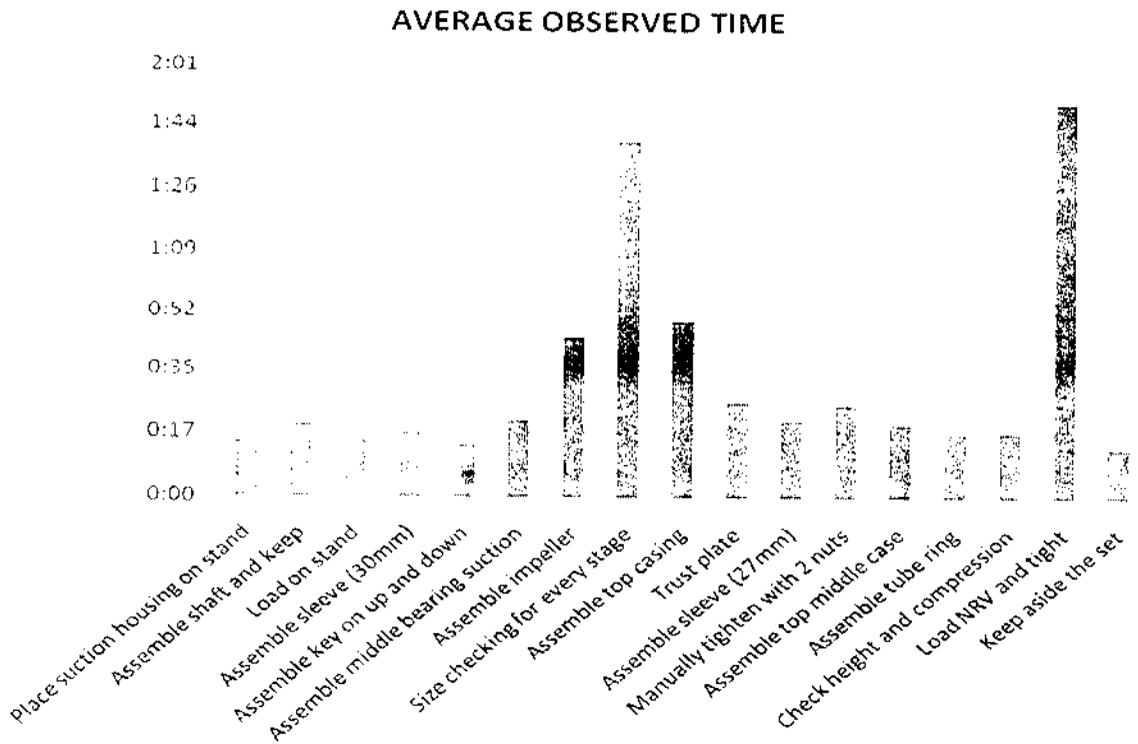
Process 15: Check height and compression

Process 16: Load NRV and tight

Process 17: Keep aside the set

Chart 4.1

Process for pump assembling section



Inference:

The graph shows the time taken for each and every sub process in pump assembling section. It has been inferred that it takes a long time to check the size and load NRV and to tight when compared to other processes.

4.2.2 Rotor assembling:

Process for rotor assembling section:

Process 1: Stud ring fitting

Process 2: Assemble lower housing

Process 3: Trust pad fitting with key

Process 4: Seating adjustment

Process 5: Assemble upper housing

Process 6: Trust bearing fitting

Process 7: Base and tread pin fitting

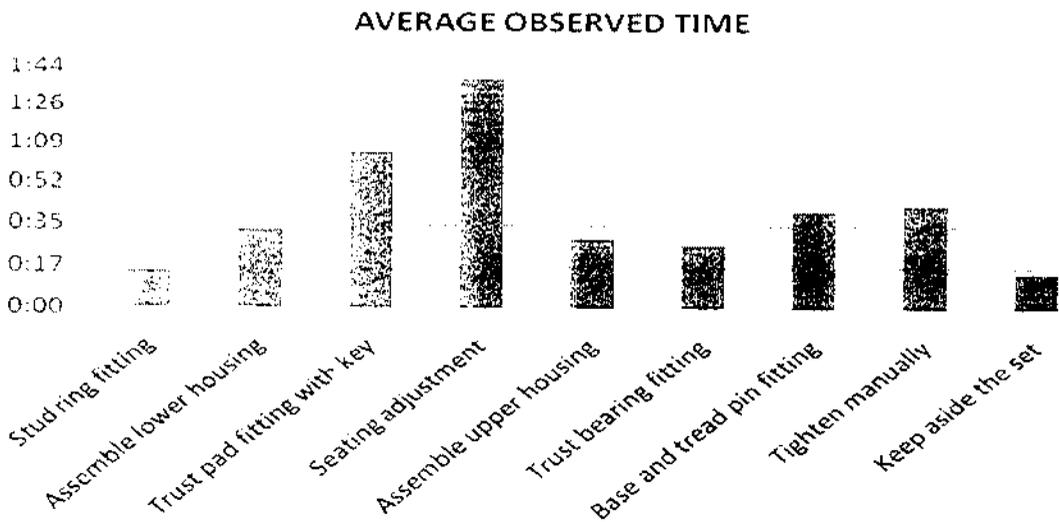
Process 8: Tighten manually

Process 9: Keep aside the set

Process 10: Trust plate.

Chart 4.2

Process for rotor assembling section



Inference:

The graph shows the time taken for each and every sub process in the rotor assembling section. It has been inferred that it takes a long time to adjust the seating and trust pad fitting with key process when compared to other processes.

4.2.3 Motor assembling:

Process for motor assembling section:

Process 1: Place KR body on stand

Process 2: Assemble upper washout & trading

Process 3: Assemble retainer ring

Process 4: Hammering

Process 5: Assemble upper housing

Process 6: Hammering

Process 7: Rubber grip fitting

Process 8: Air gun tighten with 4 nuts (8mm)

Process 9: Apply oil

Process 10: Assemble cable crone & vaser

Process 11: Assemble cable glanet

Process 12: Tighten manually

Process 13: Assemble lower vaser

Process 14: Assemble trading

Process 15: Rotor fitting and adjusting

Process 16: Assemble trust bearing

Process 17: Place base leg on stand & fit

Process 18: Hammering

Process 19: Vaser plate fitting

Process 20: Tread pin fitting

Process 21: Apply oil seal

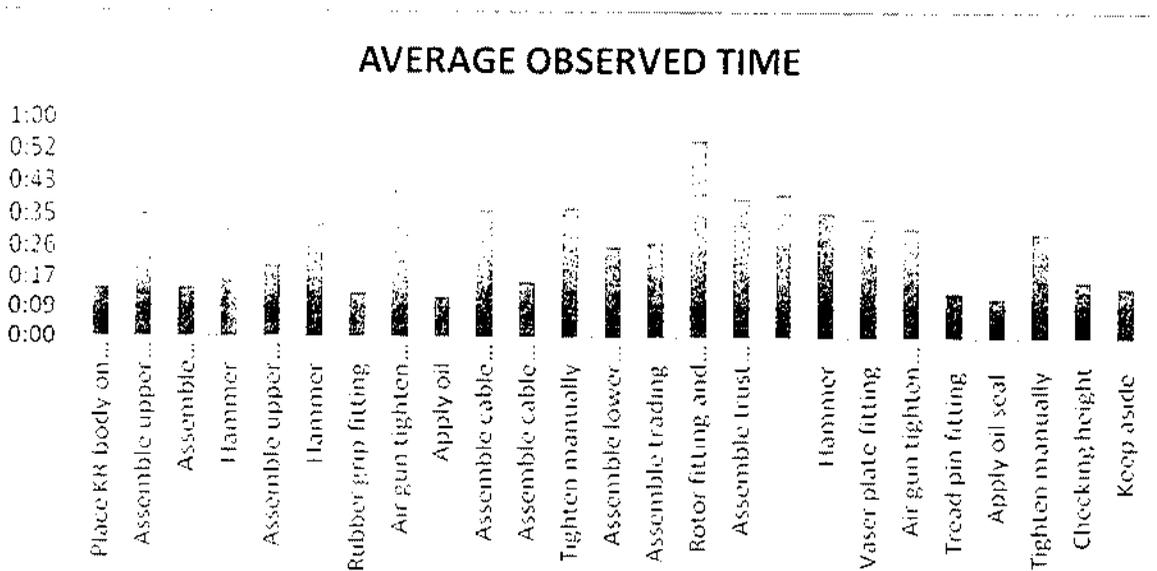
Process 21: Tighten manually

Process 21: Checking height

Process 21: Keep aside.

Chart 4.3

Process for motor assembling section



Inference:

The graph shows the time taken for each and every sub process in the motor assembling section. It has been inferred that it takes a long time to fitting rotor and tightening the nuts by using air gun when compared to other processes.

4.2.4 Winding & Testing:

Process for winding & wiring section:

Process 1: place body cover on stand

Process 2: Film paper fitting

Process 3: Starting coil wire(0.6mm) & pvc wedge fitting

Process 4: Hammering the coil wire

Process 5: Running coil wire(0.8mm) & pvc wedge fitting

Process 6: Hammering the coil wire

Process 7: Running coil wire(0.8mm) & pvc wedge fitting

Process 8: Hammering the coil wire

Process 9: Tie coil wires with pvc wire

Process 10: Cutting extra coil wires

Process 11: Adjusting wires

Process 12: Attach cable wire with coil wires

Process 13: Attaching water proof rubber tape

Process 14: Attaching cello tape

Process 15: Tie the wires with pvc wire

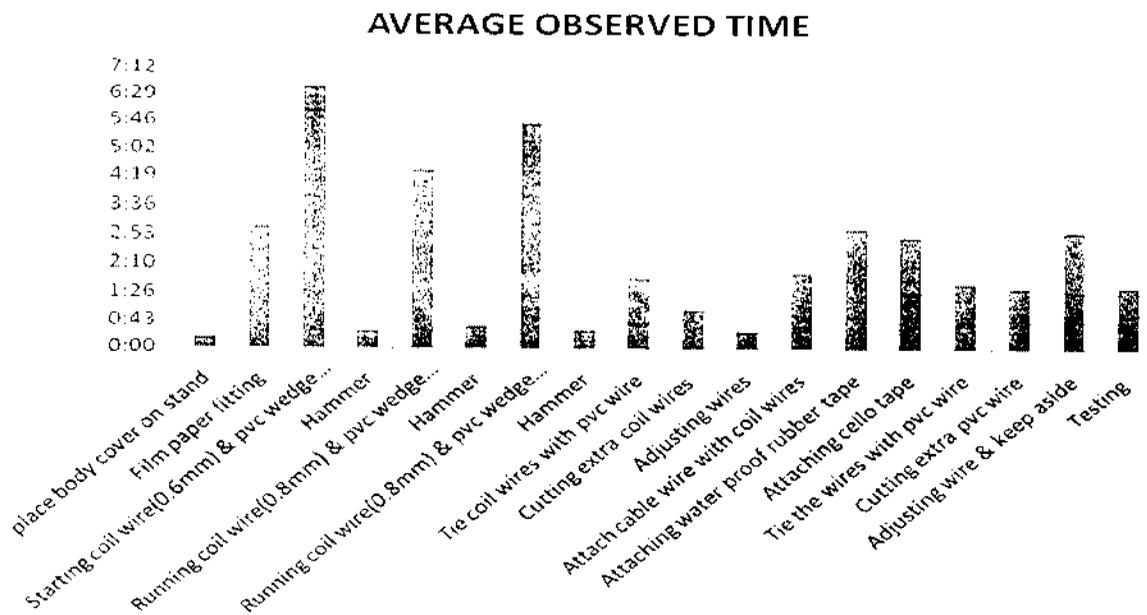
Process 16: Cutting extra pvc wire

Process 17: Adjusting wire & keep aside

Process 18: Testing the high voltage

Chart 4.4

Process for winding & wiring section



Inference:

The graph shows the time taken for each and every sub process in the motor assembling section. It has been inferred that it takes a long time to fit the pvc wedge and Starting coil wire(0.6mm) and running coil wire(0.8mm) when compared to other processes.

4.2.5 Finishing section:

Process 1: filling coolant into pump

Process 2: closing suction and delivery side with coolant cap

Process 3: putting earth screw nut and stickering

Process 4: closing the capacitor box

Process 5: attaching fan and fan cover

Process 6: finish painting, stickering and passing pressurized air

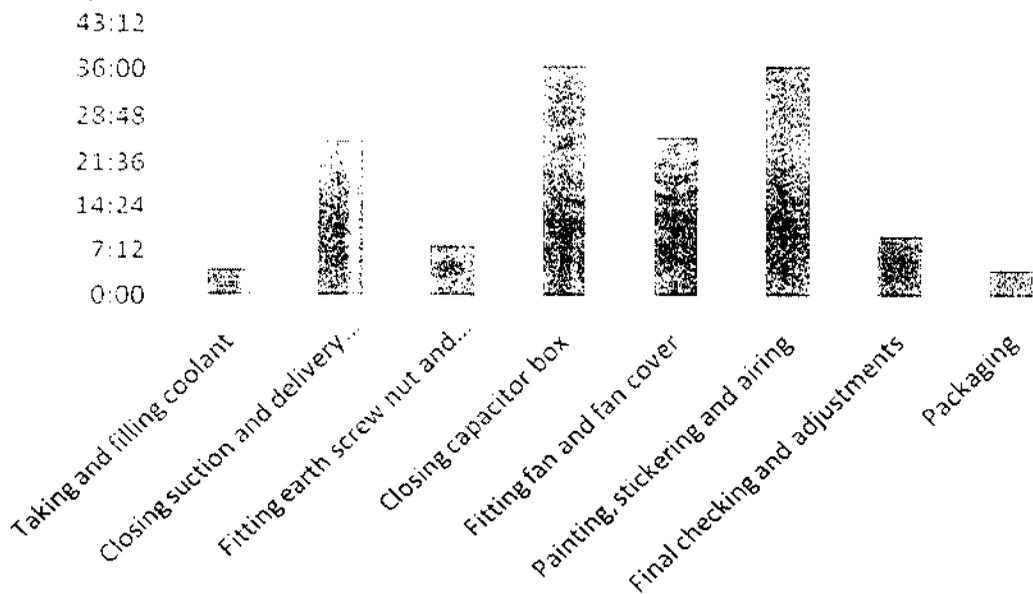
Process 7: final checking and adjustment of pumps

Process 8: packaging the dispatch.

Chart 4.5

Finishing section

Average Observed Time

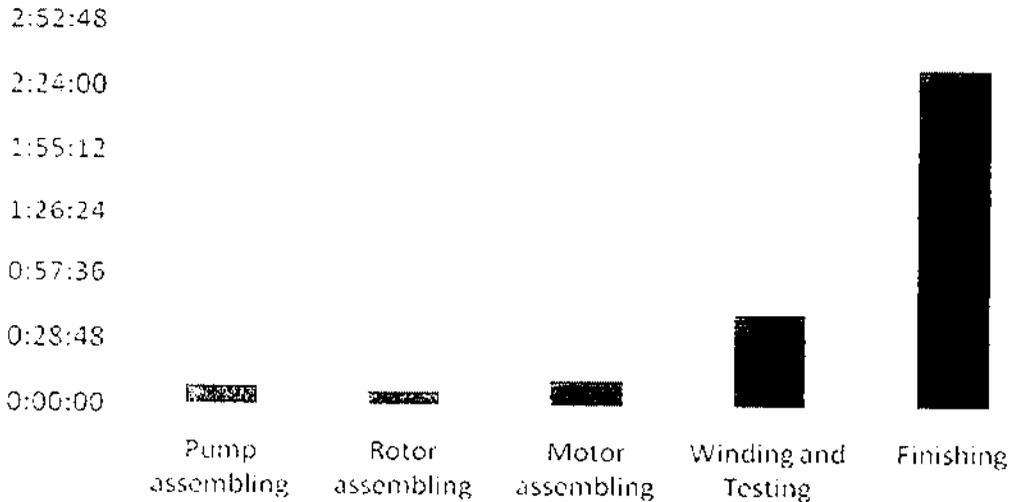


Inference:

The graph shows the time taken for each and every sub process in the finishing section. It has been inferred that it takes a long time to close the capacitor box and painting, stickering and arising when compared to other processes.

Chart 4.6

OVERALL CHART FOR AVERAGE OBSERVED TIME



Inference:

The graph shows the average observed time for every process in manufacturing the pump. It has been inferred that it takes a longest time for final finishing of the product and least time for pump.

4.3 Calculation of standard time:

Normal time = Average time * Performance rating

Standard time = Normal time / (1 - Allowances %)

4.4 CALCULATION OF ALLOWANCES:

4.4.1 Pump assembling:

Fixed allowances for men	= 8 %
Abnormal continuous bending	= 4 %
Concentration	= 4%
Standing	= 2%
Average working condition	= 1%
Repetitive work	= 1 %
	<hr/>
	20%
	<hr/>

4.4.2 Rotor assembling:

Fixed allowances for men	= 8 %
Abnormal continuous bending	= 4 %
Standing	= 2%
Average working condition	= 1%
	<hr/>
	15%
	<hr/>

4.4.3 Motor assembling:

Fixed allowances for men	= 8 %
Abnormal continuous bending	= 4 %
Hard work	= 7%

Standing	= 2%
Average working condition	= 1%
Concentration	= 4%
Vibration	= 2%
	<hr/>
	28%
	<hr/>

4.4.4 Winding & Wiring:

Process: 1 to 17

Fixed allowances for men	= 8 %
Abnormal continuous bending	= 4 %
Standing	= 2%
Average working condition	= 1%
Concentration	= 4%
Mental strain audible vibration	= 2%
Repetitive complex work	= 2 %
Average condition	= 3%
	<hr/>
	25%
	<hr/>

Process: 18

Fixed allowances for men	= 8 %
Occasional bending	= 2 %

Fatigue due to heat and humidity	= 6%
Continuous eye movement	= 2%
Repetitive work	= 2%
Average working condition	= 1%
	<hr/>
	21%
	<hr/>

4.4.5 Finishing:

Process 1,2,3

Fixed allowances for men	= 8 %
Occasional bending	= 2 %
Fatigue due to heat and humidity	= 6%
Light bench work	= 1%
Repetitive work	= 2%
Average working condition	= 1%
	<hr/>
	20%
	<hr/>

Process: 4, 5, 6

Fixed allowances for men	= 8 %
Repetitive work	= 2%
Standing	= 2%
Average working condition	= 1%
	<hr/>
	13%
	<hr/>

Process: 7

Fixed allowances for men	= 8 %
Repetitive work	= 2 %
Concentration	= 4%
Average working condition	= 1%
	<hr/>
	15%

Process: 8

Fixed allowances for men	= 8 %
Occasional bending	= 2 %
Standing	= 2%
Walking	= 2%
Average working condition	= 1%
	<hr/>
	15%

4.5 Monobloc Series:

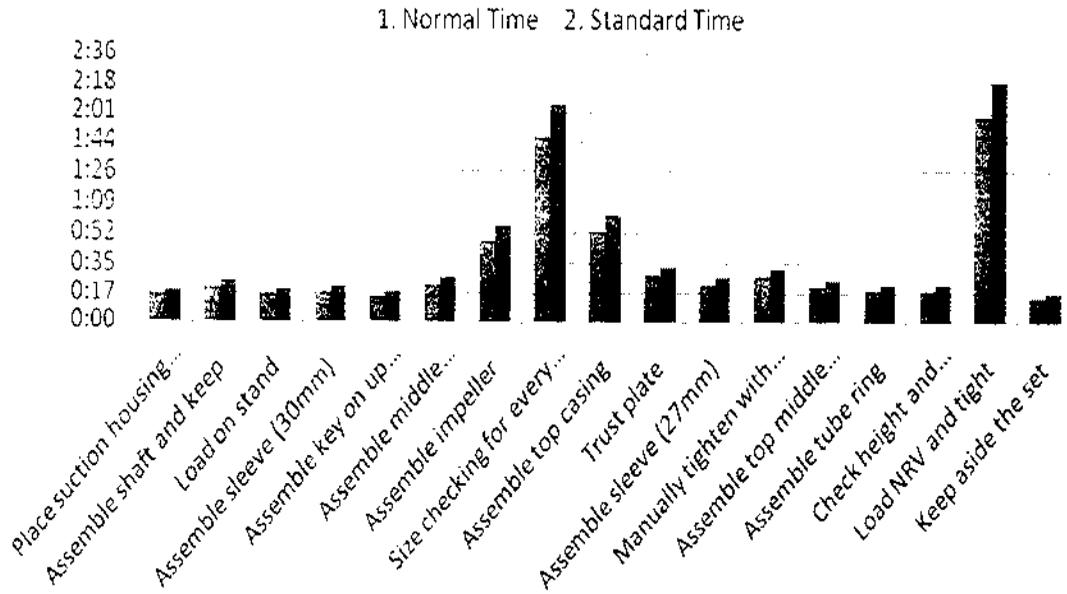
Table 4.9

Pump Assembling

DESCRIPTION	OBSERVED TIME								TOTAL OT	AVG OT	NT	ST
	1	2	3	4	5	6	7	8				
Place suction housing on	0:17	0:16	0:15	0:18	0:02	0:19	0:16	0:18	2:01	0:15	0:16	0:23
Assemble shaft and keep	0:18	0:19	0:22	0:16	0:17	0:20	0:22	0:21	2:35	0:19	0:21	0:29
Load on stand	0:14	0:16	0:18	0:12	0:20	0:16	0:13	0:15	2:04	0:16	0:17	0:23
Assemble sleeve (30mm)	0:13	0:15	0:19	0:15	0:17	0:14	0:20	0:23	2:16	0:17	0:18	0:26
Assemble key on up and down	0:15	0:18	0:16	0:14	0:02	0:18	0:14	0:17	1:54	0:14	0:15	0:21
Assemble middle bearing suction	0:18	0:19	0:25	0:22	0:18	0:24	0:21	0:19	2:46	0:21	0:22	0:31
Assemble impeller	0:49	0:39	0:40	0:45	0:41	0:43	0:48	0:50	5:55	0:44	0:47	1:07
Size checking for every stage	1:17	1:14	1:13	2:16	1:18	3:20	1:17	1:18	13:13	1:39	1:46	2:29
Assemble top casing	0:50	0:53	0:49	0:46	0:52	0:48	0:49	0:47	6:34	0:49	0:53	1:14
Trust plate	0:23	0:25	0:26	0:23	0:28	0:30	0:25	0:27	3:27	0:26	0:28	0:39
Assemble sleeve (27mm)	0:19	0:24	0:16	0:18	0:22	0:17	0:26	0:23	2:45	0:21	0:22	0:31
Manually tighten with 2 nuts	0:26	0:30	0:25	0:22	0:20	0:28	0:25	0:26	3:22	0:25	0:27	0:38
Assemble top middle case	0:20	0:17	0:22	0:18	0:20	0:23	0:18	0:21	2:39	0:20	0:21	0:30
Assemble tube ring	0:16	0:15	0:19	0:14	0:22	0:18	0:15	0:20	2:19	0:17	0:19	0:26
Check height and compression	0:18	0:16	0:20	0:15	0:16	0:17	0:19	0:21	2:22	0:18	0:19	0:27
Load NRV and tight	1:40	1:48	2:52	1:37	1:39	1:36	1:43	1:48	14:43	1:50	1:58	2:46
Keep aside the set	0:11	0:16	0:10	0:15	0:13	0:12	0:18	0:14	1:49	0:14	0:15	0:21

Chart 4.7

Pump Assembling



Inference:

It has been inferred from the above chart that the difference between normal time and standard time of operation is higher for checking the size and loading NRV and tightening when compared to other processes.

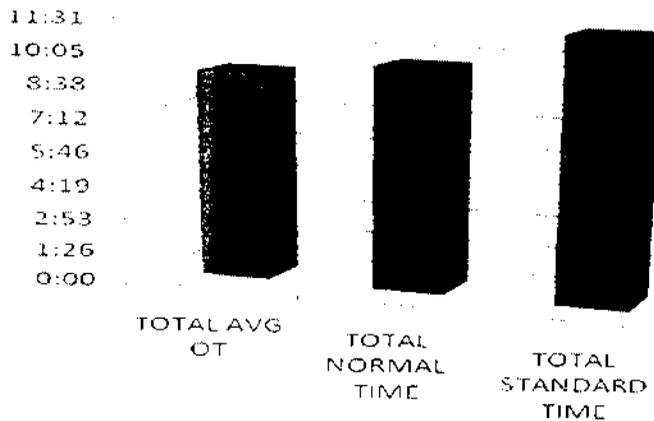
Table 4.10

OVERALL TIME FOR PUMP ASSEMBLING

(in minutes)

Total Avg. Observed Time	9:05
Total Normal Time	9:44
Total Standard Time	11:27

Chart 4.8



Inference:

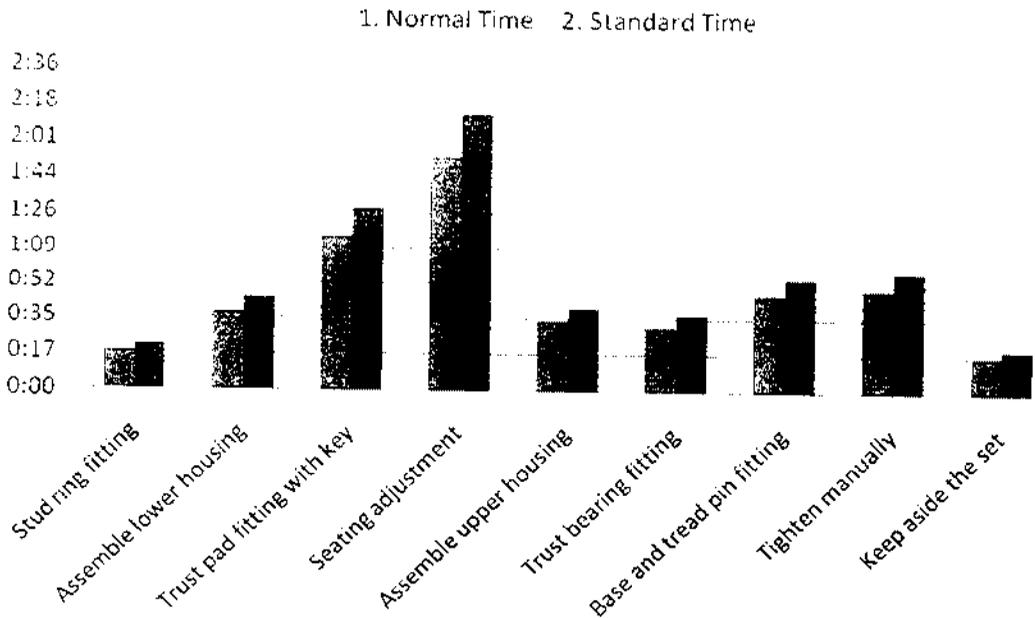
It is inferred that in pump assembling operation the difference between total normal time and total standard time is 2:23 minutes and that of Total normal time and total observed time is 39 secs.

Table 4.11
Rotor Assembling

DESCRIPTION	OBSERVED TIME								TOTAL	AVG		
	1	2	3	4	5	6	7	8	OT	OT	NT	ST
Stud ring fitting	0:11	0:18	0:14	0:12	0:34	0:15	0:14	0:10	2:08	0:16	0:18	0:24
Assemble lower housing	0:04	0:42	0:38	0:32	0:37	0:42	0:35	0:32	4:22	0:33	0:38	0:48
Trust pad fitting with key	0:58	0:50	1:04	0:56	0:56	0:58	2:10	0:53	8:45	1:06	1:15	1:36
Seating adjustment	2:06	1:37	1:52	1:13	1:10	2:42	1:20	1:08	13:08	1:38	1:53	2:23
Assemble upper housing	0:03	0:28	0:36	0:30	0:33	0:38	0:32	0:36	3:56	0:30	0:34	0:43
Trust bearing fitting	0:26	0:30	0:33	0:28	0:03	0:29	0:35	0:32	3:36	0:27	0:31	0:39
Base and tread pin fitting	0:39	0:44	0:38	0:40	0:35	0:49	0:41	0:41	5:27	0:41	0:47	1:00
Tighten manually	0:29	0:38	1:31	0:26	1:04	0:43	0:34	0:22	5:47	0:43	0:50	1:03
Keep aside the set	0:15	0:17	0:15	0:12	0:15	0:16	0:14	0:20	2:04	0:16	0:18	0:23

Chart 4.9

Rotor Assembling



Inference:

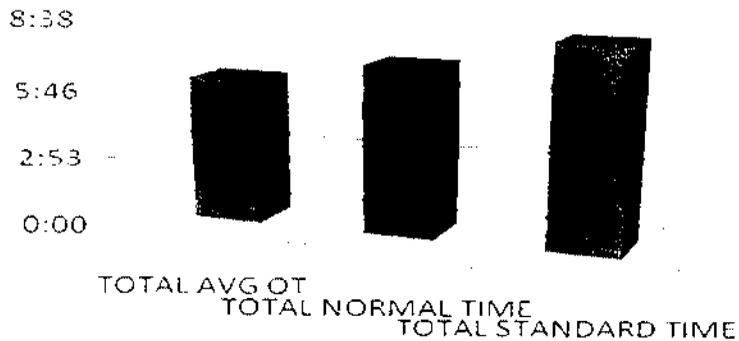
It has been inferred from the above chart that the difference between normal time and standard time of operation is higher for Seating adjustment and fitting key for trust pad when compared with other processes in Rotor assembling.

Table 4.12

OVERALL TIME FOR ROTOR ASSEMBLING

Particulars	In minutes
Total Avg. Observed Time	6:09
Total Normal Time	7:04
Total Standard Time	8:19

Chart 4.10



Inference:

It is inferred that in Rotor assembling operation the difference between total normal time and total standard time is 1:15 minutes and that of Total normal time and total observed time is 1:35 mins.

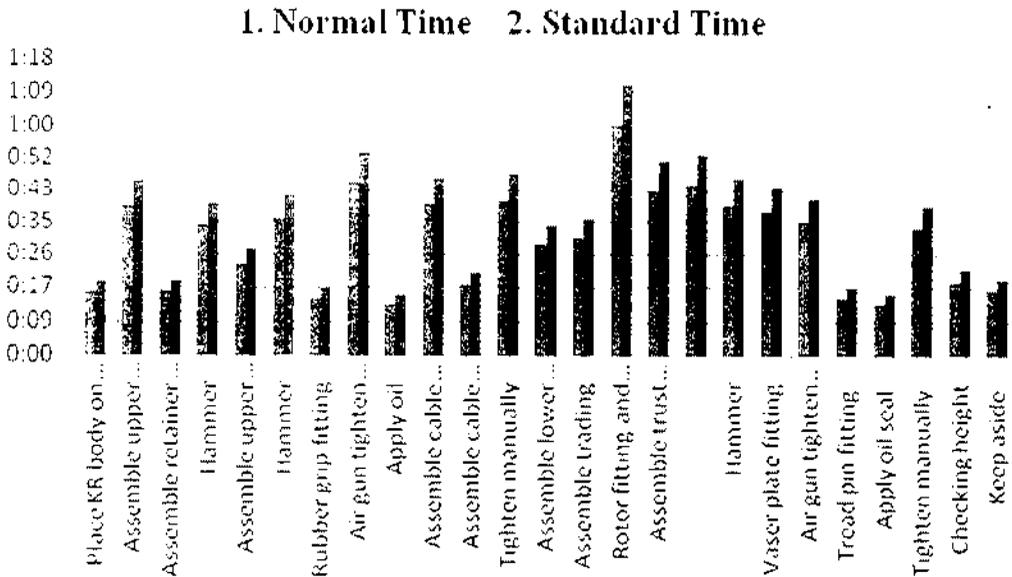
Table 4.13

Motor Assembling

DESCRIPTION	OBSERVED TIME								TOTAL	AVG		
	1	2	3	4	5	6	7	8	OT	OT	NT	ST
Place KR body on stand	0:13	0:15	0:11	0:13	0:17	0:15	0:14	0:18	1:56	0:15	0:16	0:26
Assemble upper washout & trading	0:31	0:29	0:35	0:33	0:39	0:35	0:44	0:36	4:42	0:35	0:39	1:03
Assemble retainer ring	0:12	0:02	0:19	0:22	0:17	0:13	0:15	0:18	1:58	0:15	0:16	0:26
Hammer	0:26	0:24	0:42	0:30	0:29	0:45	0:25	0:24	4:05	0:31	0:34	0:54
Assemble upper housing	0:16	0:14	0:19	0:28	0:20	0:18	0:31	0:22	2:48	0:21	0:23	0:37
Hammer	0:32	0:29	0:42	0:35	0:32	0:25	0:30	0:34	4:19	0:32	0:36	0:57
Rubber grip fitting	0:10	0:12	0:18	0:11	0:14	0:11	0:13	0:16	1:45	0:13	0:14	0:23
Air gun tighten with 4 nuts (8mm)	0:39	0:35	0:49	0:40	0:39	0:42	0:51	0:36	5:31	0:41	0:46	1:13
Apply oil	0:10	0:08	0:16	0:11	0:10	0:13	0:15	0:12	1:35	0:12	0:13	0:21
Assemble cable crome & vaser	0:24	0:48	0:34	0:32	0:44	0:45	0:28	0:32	4:47	0:36	0:39	1:04
Assemble cable glanet	0:14	0:12	0:16	0:23	0:20	0:14	0:17	0:15	2:11	0:16	0:18	0:29
Tighten manually	0:38	0:26	0:28	0:39	0:57	0:49	0:31	0:28	4:56	0:37	0:41	1:06
Assemble lower vaser	0:25	0:28	0:18	0:26	0:34	0:28	0:27	0:23	3:29	0:26	0:29	0:46
Assemble trading	0:20	0:29	0:26	0:32	0:21	0:42	0:24	0:26	3:40	0:28	0:30	0:49
Rotor fitting and adjust	0:43	0:51	1:35	0:43	0:56	0:50	0:44	0:58	7:20	0:55	1:01	1:38
Assemble trust bearing	0:34	0:36	0:32	1:06	0:42	0:39	0:24	0:43	5:16	0:40	0:43	1:10
Place base leg on stand & fit	0:28	0:52	0:46	0:48	0:56	0:30	0:29	0:37	5:26	0:41	0:45	1:12
Hammer	0:45	0:24	0:32	0:57	0:41	0:26	0:29	0:32	4:46	0:36	0:39	1:03
Vaser plate fitting	0:32	0:28	0:30	0:35	0:46	0:37	0:31	0:34	4:33	0:34	0:38	1:01
Air gun tighten with 4 nuts	0:26	0:31	0:29	0:41	0:38	0:28	0:27	0:32	4:12	0:32	0:35	0:56
Tread pin fitting	0:13	0:18	0:15	0:10	0:13	0:16	0:12	0:10	1:47	0:13	0:15	0:24
Apply oil seal	0:12	0:10	0:15	0:11	0:10	0:13	0:12	0:14	1:37	0:12	0:13	0:22
Tighten manually	0:35	0:32	0:42	0:30	0:25	0:22	0:28	0:26	4:00	0:30	0:33	0:53
Checking height	0:12	0:16	0:21	0:19	0:17	0:15	0:13	0:23	2:16	0:17	0:19	0:30
Keep aside	0:15	0:13	0:17	0:14	0:16	0:15	0:14	0:17	2:01	0:15	0:17	0:27

Chart 4.11

Overall Chart for Motor Assembling



Inference:

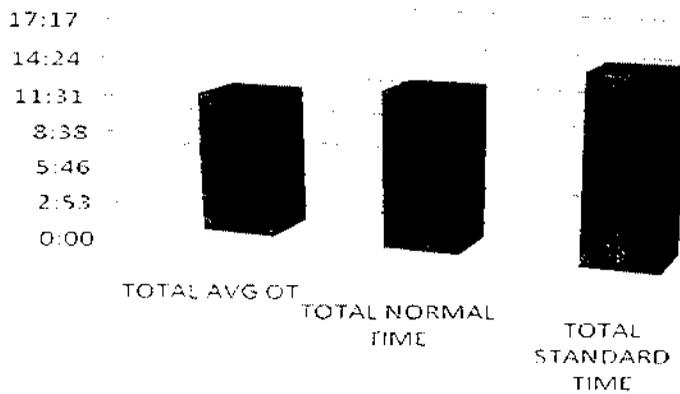
It has been inferred from the above chart that the difference between normal time and standard time of operation is higher for Air gun tighten with 4 nuts (8mm), Rotor fitting and adjusting and tightening manually when compared with other processes in Motor Assembling.

Table 4.14

OVERALL TIME FOR MOTOR ASSEMBLING

Particulars	In minutes
Total Avg. Observed Time	11:22
Total Normal Time	12:30
Total Standard Time	14:43

Chart 4.12



Inference:

It is inferred that in Motor assembling operation the difference between total normal time and total standard time is 2:13 minutes and that of Total normal time and total observed time is 1:08 minutes.

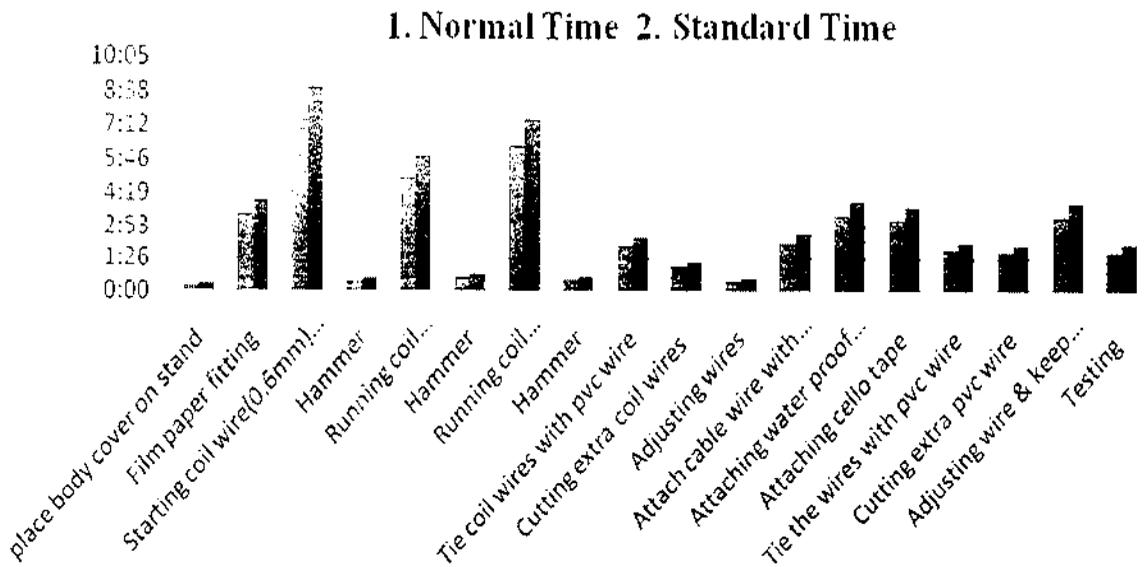
Table 4.15

Winding and Testing section

DECSRIPTION	OBSERVED TIME								TOTAL OT	AVG OT	NT	ST
	1	2	3	4	5	6	7	8				
place body cover on stand	0:16	0:17	0:15	0:18	0:16	0:19	0:20	0:18	2:19	0:17	0:20	0:33
Film paper fitting	2:16	5:11	3:24	2:57	2:26	3:10	2:45	2:27	24:36	3:04	3:36	5:48
Starting coil wire(0.6mm) & pvc wedge fitting	5:48	5:53	6:42	6:56	7:08	6:55	7:42	6:37	53:41	6:43	7:51	12:40
Hammer	0:28	0:33	0:30	0:21	0:28	0:29	0:20	0:32	3:41	0:28	0:32	0:52
Running coil wire(0.8mm) & pvc wedge fitting	4:20	3:50	4:49	4:46	3:52	5:48	3:49	4:47	36:01	4:30	5:16	8:30
Hammer	0:32	0:24	0:45	0:57	0:41	0:26	0:32	0:29	4:46	0:36	0:42	1:07
Running coil wire(0.8mm) & pvc wedge fitting	4:14	5:13	7:10	6:41	4:26	4:58	7:38	5:28	45:48	5:43	6:42	10:48
Hammer	0:42	0:30	0:29	0:03	0:25	0:45	0:29	0:31	3:54	0:29	0:34	0:55
Tie coil wires with pvc wire	2:12	1:53	1:46	2:52	1:49	1:12	1:32	1:26	14:42	1:50	2:09	3:28
Cutting extra coil wires	0:53	0:42	1:12	0:53	0:46	1:36	0:58	1:09	8:09	1:01	1:12	1:55
Adjusting wires	0:32	0:23	0:03	0:41	0:28	0:35	0:25	0:29	3:36	0:27	0:32	0:51
Attach cable wire with coil wires	1:42	1:53	1:46	1:39	2:52	1:33	2:41	1:36	15:42	1:58	2:18	3:42
Attaching water proof rubber tape	2:53	3:01	2:58	2:53	3:13	3:19	2:55	3:08	24:20	3:03	3:34	5:44
Attaching cello tape	3:18	2:33	2:36	3:48	2:42	2:58	2:19	2:37	22:51	2:51	3:21	5:23
Tie the wires with pvc wire	2:26	1:33	1:52	1:05	1:46	1:39	1:35	1:31	13:27	1:41	1:58	3:10
Cutting extra pvc wire	1:44	1:37	1:39	1:41	1:38	1:43	1:04	1:37	12:43	1:35	1:52	3:00
Adjusting wire & keep aside	2:53	2:46	2:54	2:51	2:57	2:49	2:53	3:46	23:49	2:59	3:29	5:37
Testing	1:43	1:26	1:39	1:34	1:31	1:54	1:29	1:28	12:44	1:35	1:53	2:23

Chart 4.13

Overall Chart for Winding and Testing section



Inference:

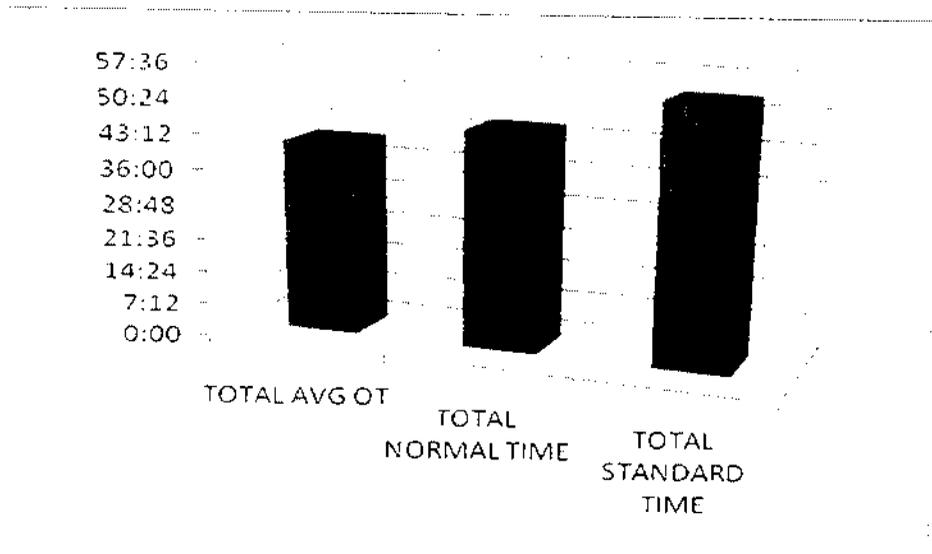
It has been inferred from the above chart that the difference between normal time and standard time of operation is higher for Starting coil wire(0.6mm) & pvc wedge fitting, Running coil wire(0.8mm) & pvc wedge fitting , Adjusting wire & keep aside when compared with other processes in Welding and Tightening section.

Table 4.16

OVERALL TIME FOR WINDING AND TESTING

Particulars	In minutes
Total Avg. Observed Time	40:51
Total Normal Time	45:45
Total Standard Time	53:50

Chart 4.14



Inference:

It is inferred that in Winding and wiring operation the difference between total normal time and total standard time is 8:05 minutes and that of Total normal time and total observed time is 5:34 minutes.

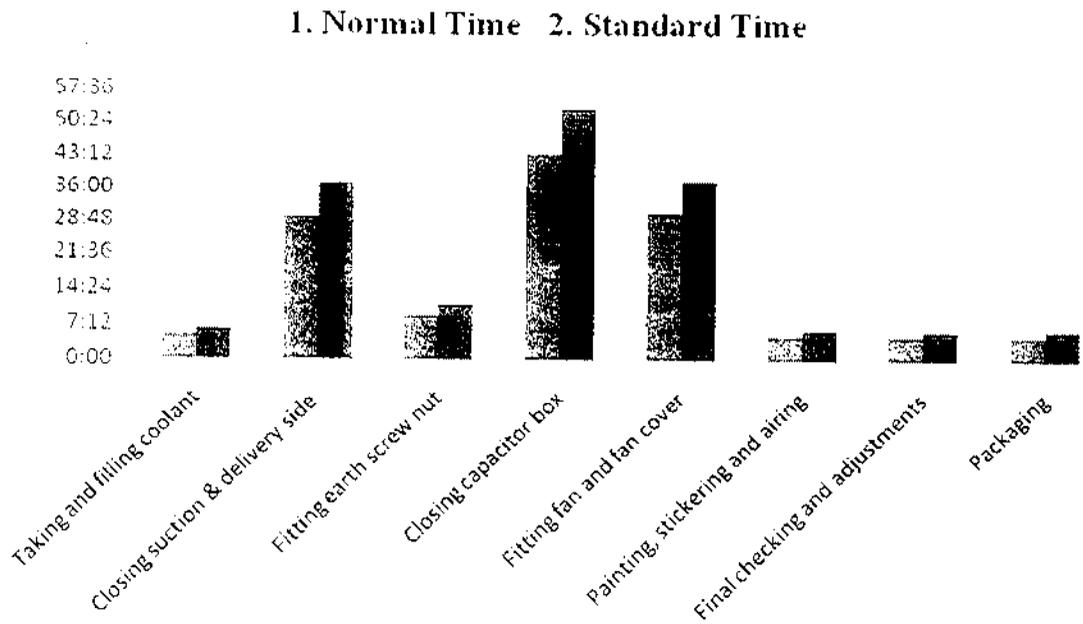
Table 4.17

Finishing section

DESCRIPTION	OBSERVED TIME								TOTAL	AVG		
	1	2	3	4	5	6	7	8	OT	OT	NT	ST
Taking and filling coolant	4:38	4:28	5:09	3:32	4:16	4:56	4:16	4:09	35:24	4:26	5:11	6:28
Closing suction and delivery side with coolant cap	26:11	24:31	29:33	30:16	24:54	20:27	25:06	22:12	3:23:10	25:24	29:43	37:08
Fitting earth screw nut and stickering	7:26	8:16	7:12	7:16	9:13	8:36	8:56	9:07	1:06:02	8:15	9:13	11:31
Closing capacitor box	36:07	37:12	42:12	46:56	33:12	31:19	33:12	36:12	4:56:22	37:03	43:43	53:19
Fitting fan and fan cover	28:38	32:11	23:12	25:53	24:16	28:08	24:16	22:12	3:28:46	26:06	30:48	37:33
Painting, stickering and airing	38:32	36:42	33:23	39:52	37:12	40:12	37:12	33:16	4:56:21	37:03	5:13	6:22
Final checking and adjustments	9:12	9:16	7:25	15:09	8:38	7:49	8:28	14:38	1:20:35	10:04	5:13	6:17
Packaging	34:26	31:11	29:23	40:14	31:12	35:55	31:12	41:29	4:35:02	4:26	5:13	6:22

Chart 4.15

Overall chart for Finishing section



Inference:

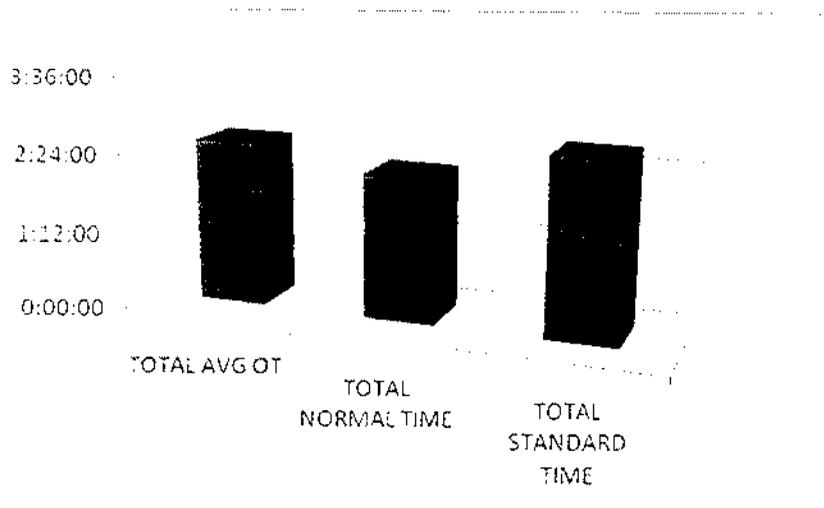
It has been inferred from the above chart that the difference between normal time and standard time of operation is higher for Closing suction and delivery side, closing capacitor box and fitting fan and fan cover when compared with other processes in finishing section.

Table 4.18

OVERALL TIME FOR FINISHING

Particulars	In minutes
Total Avg. Observed Time	2:32:45
Total Normal Time	2:14:17
Total Standard Time	2:45:02

Chart 4.16



Inference:

It is inferred that in Finishing process the difference between total normal time and total standard time is 18:28 minutes and that of Total normal time and total observed time is 31:25 minutes.

Table 4.19**Overall total for NT and ST**

ACTIVITES	NORMAL TIME	STANDARD TIME
Pump assembling	9:44	11:27
Rotor assembling	7:04	8:19
Motor assembling	12:30	20:10
Winding & wiring	47:48	1:17:06
Finishing	2:14:17	2:45:02
TOTAL	7:20:17	19:58:08

Interpretation:

The calculation of standard time and normal time for monobloc pump manufacturing. Average time that is found by adding the time for each process. Next performance rating for each worker is to be found. This performance is ability of worker to do activity with respect to his surrounding condition. The performance of worker is rated using Westinghouse system. The reason for using this system, it includes all attributes of worker such skill, effort, conditions, consistency which is satisfactory to find their performance level. They are calculated and tabulated. Then normal time is calculated by multiplying average time with performance rating. The allowance is calculated for each worker based on their working condition. The allowances extra time provided for every individual worker to fulfill their basic needs. The standard time is calculated by multiplying allowance with normal time. Here the maximum time is consumed by finishing section. The reason is it is the final process to complete the work by way of testing, painting and packing. In the testing process the motor voltage will be test for maximum one minute in order to check its coil strength and bearing sound. The overall time normal time is 7:20:17 and standard time is 19:58:08 hours takes to complete a monobloc pump.

CHAPTER V
FINDINGS, SUGGESTION AND
CONCLUSION

CHAPTER 5

FINDINGS, SUGGESTION AND CONCLUSIONS

5.1 FINDINGS:

Results:

Standard time in hours for a pump = 19:58:08

It takes 44.36 minutes to complete the pump.

Total working hours = 8 (480 minutes)

$$=480/44.36$$

$$=10.82$$

No .of workers = 9

Total no. pumps produced per day = $9*10.82$

$$=98 \text{ pumps}$$

Actual no .of pumps to be produced per day =120

Production that was lost = $120-98 = 22$ pumps

- It is found that capacity of company is to produce 120 pumps per day but currently it is producing 98 pumps only.
- In pump assembling operation the difference between total normal time and total standard time is 2:23 minutes and that of total normal time and total observed time is 39 secs.

- In Rotor assembling operation the difference between total normal time and total standard time is 1:15 minutes and that of Total normal time and total observed time is 1:35 mins.
- In Motor assembling operation the difference between total normal time and total standard time is 2:13 minutes and that of Total normal time and total observed time is 1:08 minutes.
- In Winding and wiring operation the difference between total normal time and total standard time is 8:05 minutes and that of Total normal time and total observed time is 5:34 minutes.
- In Finishing process the difference between total normal time and total standard time is 18:28 minutes and that of Total normal time and total observed time is 31:25 minutes.
- It is found the parts that are procured from outside have some issues in specification such as the flange doesn't get aligned easily with the casting. This becomes a cause for increased time consumption.
- Pneumatic machine has some maintenance issues which often need to be adjusted that increases worker's fatigue and time.
- The pathway for material handling is quite congested, i.e., flow of materials from sub-assembling section to wiring section consumes more time. This can be sorted out by altering the layout.

5.2 SUGGESTIONS:

- Time study can be a base for settlement of production for workers.
- The stress for the workers in the winding department is more due to over load and it can be reduced.

- The work load can be reduced/increased to certain extent in some of the department based on the work study.
- Improvements can be made in material handling by altering the layout.
- Materials received can be checked for its compliance with the requirements.

5.3 CONCLUSION

The study gives a basis for identifying whether the production capabilities need to be improved or not. It shows that the targeted production level is not achieved which is possible by sorting out some minor issues. It also assists in redesigning the layout, if necessary. Measurement of performance of workers provides helps to plan for incentives for workers.

SCOPE FOR FURTHER STUDY

- Further the method study and the Motion study can be conducted to improve the operational efficiency and to increase the productivity in the manufacture and the assembling process.
- This study can be applied to other manufacturing companies and the analysis is adjusted as per the industry type, processes followed, policies and procedures of the company, size of the company, etc. The study can be a base for designing and redesigning the layout.

BIBLIOGRAPHY

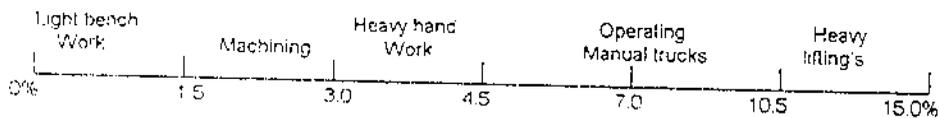
BIBLIOGRAPHY

1. Vincent G. Reuter, Work Measurement Practices, Field Trip Survey, Arizona, December 1968.
2. Richard L. Shell, Work Measurement for Indirect Labor Activities, Industrial Engineering, November 1971.
3. Henry De Vos, Management Services: Manufacturing Management, The Journal of Accountancy, December 1966.
4. Ralph M. Barnes, "Industrial Engineering Survey—1967," Journal of Industrial Engineering, 18:12(December, 1967), xii.
5. John W. Hannon, "A Fresh Look at Industrial Engineering," Journal of Industrial Engineering, 19:5(May 1968), xi.

APPENDIX

B - E VARIABLE ALLOWANCE

B. Energy expended in muscular effort

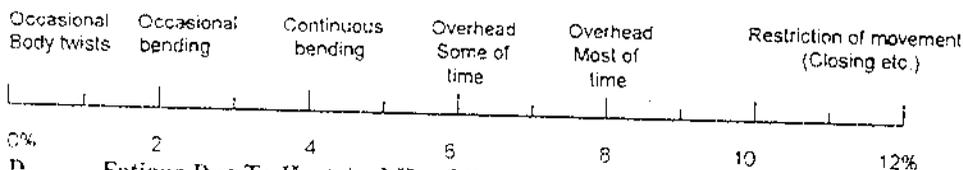


C. Dynamic and static work performed (through movement or posture)

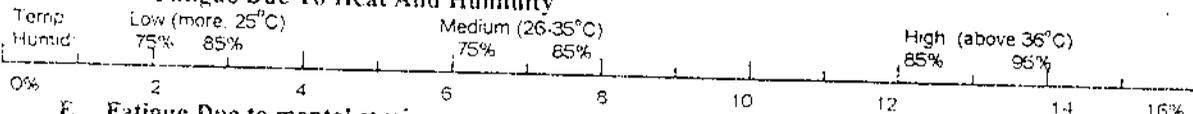
C.1. Standing or walking

MEN = 2% WOMEN = 4%

C.2. Abnormal posture

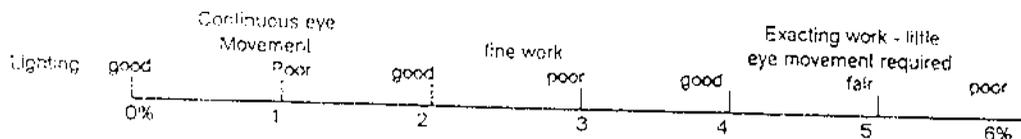


D. Fatigue Due To Heat And Humidity

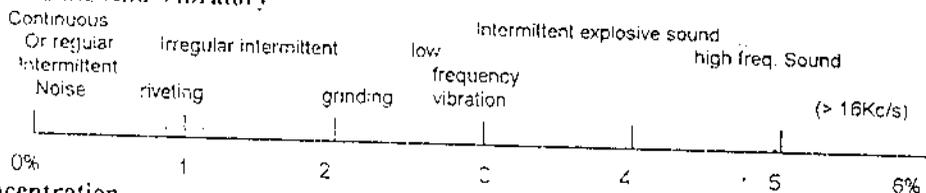


E. Fatigue Due to mental strain

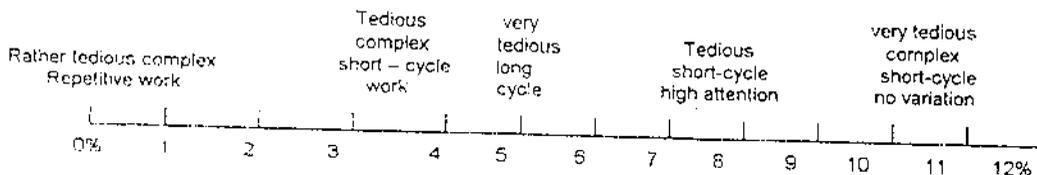
E.1. Visual



E.2. Audible And Vibratory



E.3. Concentration



F. Working conditions generally

