Productivity Enhancement of an Electromechanical Relay Manufacturing Company through Work Measurement Analysis

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ABSTRACT—*This paper describes the results of a Work Measurement field study conducted in an electromechanical relay manufacturing company to improve worker productivity by reducing the production time and there by labour cost through various interventions in a repetitive production task. After identifying the key product of the company a complete time study has been carried out to find out the existing times of all the assembly operations and various improvements with regard to changing workplace layout, designing new work methods ,combining activities if possible, Modification of tools, Allocating the workers to handle multiple equipments if possible ,implementing semiautomatic or machineries instead of manual, redesigning the fixtures etc has been made and the effect of which is quantitatively assessed by using predetermined motion time systems(PMTS)*.

Keywords— Work measurement, Worker productivity, Labour cost, Time study, Predetermined Motion Time System (PMTS)

1. INTRODUCTION

The search for a better way to do things has progressed since the birth of mankind. Man's self interest demands more efficient procedures to do work. From its earliest beginnings, industry always has been concerned in some degree with methods, particularly manufacturing methods. Today the method or procedures associated with every activity of every kind of organization are of concern. The interest in methods always is greatest during periods of low profit and severe competition. Work measurement offers one of the most reliable ways to achieve the benefits of increased production at lower cost for the advantage of everyone-managers, workers and consumers : (1) it accomplishes this by greatly assisting in methods improvement , which in turn, reduces the labour content or cost to produce;(2) it provides a standard of performance that greatly facilitates rational management of an organisastion's labour operations (3) When the production cost reduces, the price to the consumer also reduces and the company becomes more competitive and this eventually protects the employees job[5]. Work measurement is the application of techniques developed to estimate the time needed by suitably qualified and adequately motivated workers to perform a specified task at a specified level of performance. Time measures are essential for labor cost control, cost estimation, planning and scheduling, and evaluation of alternatives, and often serve as the basis for incentive plans. This field study deals with identifying the existing standard time of all the operations of the key product, identifying the ineffective work content, contemplating different improvements to reduce the production time and hence the labour cost and then quantitatively assessing the possible time savings using predetermined time systems. A predetermined time system follows essentially the same procedure as a time study except that motions are identified and classified in a structured manner rather than timing the segments (elements of operation). Establishing work methods involves decisions regarding such scientific topics as, for example, the time for the eye to recognize objects or the possible simultaneous motions of which the body members are capable.

2. PROBLEM DEFINITION

Electromechanical relay manufacturing industries in India are facing tough competition from those of other countries, especially China and Taiwan in the liberalized global market scenario. The prices of the electromechanical relays have drastically come down in the past decade due to globalization. In other words, the Indian companies like Guardian Controls limited (GCL) confront with severe competition from freely available imported equivalents offered at incredibly low prices, causing price erosion of electromechanical relays. At the same time, the costs of raw materials are increasing day by day, which brings down the profit margin of the industries in this sector drastically. Companies need to cut its production cost if it is to survive in light of the prevailing tough competition. One of the thrust area would be to standardize the work and looking at the possible improvements in the production process and work methods which will reduce the production time and labour cost. A cost split up of the company is shown below in the following pie chart.

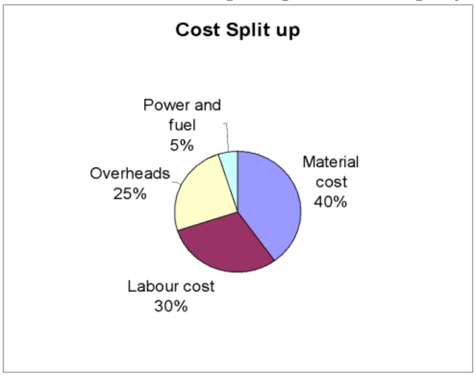

Fig 1: Cost Split up

The company needs to cut its production cost if it is to survive in light of the prevailing tough competition. It can be inferred that the study which helps the labour cost to reduce will help the company in reducing its total production cost to a great extent. A work measurement study to standardize the work and on its key product, setting standard time of all the operation of the key product, looking at the possible improvements and then assessing those changes quantitatively.

3. METHODS

Identification of key product using Pareto analysis- In order to conduct a Pareto analysis details regarding company's monthly production for the past year and the contribution from each item has been taken. From that, usage value of each item has been calculated. After identifying the total contribution per month of all the products they are arranged in the descending order of their contribution. The results of the analysis is tabulated in Table 1.Pareto analysis shows that the items S-17, S-20 and S-19 accounts for the A items. The item which shows the maximum contribution is S-17 which is the key product of the company. Because of the huge amount of time involved in any work measurement study it has been decided to conduct a work measurement analysis only to the key product which in this case is S-17 automobile relay. All the assembly operations required to produce S-17 relay are studied in detail. Details regarding the flow of work, different subassembly lines, experience of workers, existing methods for scheduling etc was analysed in detail to get a thorough knowledge pertaining to the operations as well as workers.

Items (Products)	Total Contribution (Rs)	(% Contribution)
S17	92625	25%
S20	78400	21.2%
S19	52605	14.2%
S31	30000	8.1%
S18	28176	7.6%
S29	27000	7.3%
S25	20000	5.4%
S11	15000	4.1%
Coinbox Relay	14000	3.8%
S27	10000	2.7%
S76	1150	0.03%
S79	750	0.02%

Table 1: Pareto Analysis

3.1 Time Study

As a prerequisite for conducting time study a thorough analysis has been made and data regarding the required components, equipments and machineries, fixtures and tools, detailed work methods, inspection procedures etc have been collected. The standard procedure for time study has been followed to obtain the existing standard time of all the operations. For rating the ILO,s recommendations[1] have been used. Relaxation Allowances have been calculated in accordance with the tables developed by Peter Steele and partners (United Kingdom) which is also published in ILO's book Introduction to work study[4,10]. The standard time obtained for all the operations are summarized in table 2

During the work measurement study the improvement potential of all the operations with respect to the production time has been contemplated. Certain jobs were found to have great extent of improvement potential.

S-17 Relay

Sl. No	Job	Normal Time (sec)	Allowance %	Standard Time (sec)
1	Coil terminal assembly	10.76	15	12.4
2	Coil Terminal Tinning	4.23	20	5.1
3	Coil Winding	12.89	15	14.82
4	Coil Lead Soldering	7.08	16	8.2
5	Frame Assembly	8.42	14	9.6
6	Base Assembly	14.05	13	15.88
7	Final Assembly and Calibration	18.5	14	21.1
8	Braidedwire relay welding	7.32	14	8.34
9	Relay Tinning	6.73	18	7.94
10	Relay Printing	5.97	17	6.98
11	Contact Cleaning	8.24	13	9.3
12	Relay Air Purging	3.6	15	4.75
13	QA inspection	7.01	16	8.13
14	Visual Inspection and primary Packing	14.73	15	16.94
15	NO Terminal Assembly	8.23	14	9.4
16	NC Terminal Assembly	8.57	14	9.8
17	SpringTension Adjusting	4.7	13	5.31
18	Change Over Contact Assembly	7.9	14	9
19	Armature Assembly	6.3	14	7.2
20	Braided wire welding	2.5	14	2.85
21	Braided Wire Cutting	2.03	15	2.33
22	Braided wire Armature welding	5.4	15	6.21
Total time				201.58

Table 2: Standard time of different jobs to produce

3.2 *Validation of MTM-2*

In order to quantitatively assess the possible improvements, the predetermined time system: MTM-2 has been employed. The validity of predetermined motion time systems in setting production standards for different industrial tasks has been an extensive area of research for many decades[1,14]. As a prerequisite for using MTM-2 in this industrial environment the accuracy of it is checked against the time study value which has already being obtained. For that, the existing job time has been calculated using MTM-2 for certain jobs[5,7]. The results have been tabulated in table 3

The error percentage between MTM-2 and the actual time study in these jobs are within 5 percentages. So the use of MTM-2 has been validated in this industrial work environment. The outcome of this analysis is that, MTM-2 can be effectively used to assess the improvements quantitatively for the above jobs.

Sl No	Job	Normal Time from time study (sec)	Time obtained from MTM -2 (sec)	Error %
1	Coil terminal assembly	10.76	10.64	1.1
2	Coil Lead Soldering	7.08	7.02	0.85
3	Final Assembly and Calibration	18.5	18.2	1.62
4	Frame Assembly	8.42	8.75	(3.9)
5	Base Assembly	14.05	13.85	1.4
6	Relay Tinning	6.73	6.4	(4.9)
7	Relay Printing	5.97	6.01	(0.67)
8	NO Terminal Assembly	8.23	7.9	4
9	NC Terminal Assembly	8.57	8.5	0.82
10	Change Over Contact Assembly	7.9	8.29	(4.93)
11	Armature Assembly	6.3	6.4	(1.5)

Table 3: Validation of MTM-2

Among the many assembly operations to make S-17 relay nine jobs which show a great amount potential for improvements have been selected for study. The feasibility of all the changes have been analysed and it is found that the changes can be incorporated in the company. The proposed work methods with all the suggested changes have been visualized and analysed using MTM-2.

The improvements suggested include -Changing workplace layout so as to reduce the movement of hands of the worker, Designing new work methods so that the worker will be able to make simultaneous motion of the hands, combining activities, modification of tools, Allocating the workers to handle multiple equipments, implementing semiautomatic or machineries instead of manual to reduce fatigue of workers and also to increase production rate, redesigning the fixtures so as to reduce the movement of hands etc. The total expected cost for all the changes is estimated as Rs. 152500/-

4. EXPECTED SAVINGS

New work method which incorporates the above said changes have been visualized and the corresponding time has been found out using MTM-2. The expected differences in time because of the changes, have been tabulated and presented in table 4

Sl No	Job	Time (Present method) MTM-2	Time (Proposed) sec	% savings
1	Coil terminal assembly	10.64	8.69	18.3
2	Coil Lead Soldering	7.02	5.5	21.6
3	Base Assembly	13.85	11.4	17.7
4	Relay Tinning	6.4	3.7	42.2
5	Relay Printing	6.01	4.3	28.4
6	NO Terminal Assembly	7.9	6.33	19.8
7	NC Terminal Assembly	8.5	6.33	25.5

8	ChangeOverContact Assembly	8.29	6.15	25.9
9	Armature Assembly	6.4	5.25	18

Table 4: Existing and Proposed Times, Percentage savings

The new standard time for the proposed methods has been found out by incorporating the allowances into the Normal Time which is established from MTM-2 analysis.

5. RESULTS AND SUMMARY

The expected reduction in standard time after the changes are implemented are tabulated below in table 5

Sl No.	Jobs	Standard Time Existing (sec)	Standard Time New (sec)	Savings in sec
1	Coil terminal assembly	12.24	10	2.24
2	Coil Lead Soldering	8.21	6.38	1.83
3	Base Assembly	15.65	12.89	2.76
4	Relay Tinning	7.55	4.4	3.15
5	Relay Printing	7.03	5.03	2
6	NO Terminal Assembly	9	7.22	1.78
7	NC Terminal Assembly	9.7	7.22	2.48
8	Change Over Contact Assembly	9.45	7.01	2.44
9	Armature Assembly	7.3	5.98	1.32
Total savings in sec				20

Table 5: Existing and Proposed Standard Time

Savings in labour cost

Total man seconds for making S-17 relay obtained from Time study	= 201.58 sec
Possible savings from the proposed method	= 20sec
Percentage savings of time	= 20/201.58 = 9.92%
Man-hour rate in the plant	= Rs. 28/-
Existing labour cost per piece	= 28/ (3600/201.58) = Rs 1.57/ -
Labour cost per piece for proposed method	= 28/ {3600/ (201.58-20)} =Rs 1.41
Savings in labour cost per relay	= 1.57-1.41 = Rs 0.16/ -
The cost of implementing the changes	= Rs. 152500/-
The average monthly demand for S-17 relay	= 71200 units
Assuming this demand for future also, payback period	= 152500/ 71200x0.16 = 13.4 months

From the above calculations it is clear that by implementing the suggested changes, the total time to produce S-17 relay will be reduced by 9.92 %. The same reduction will be reflected in the labour cost also. The cost of implementing the suggested changes has been worked out. Assuming the present demand for future also, the payback period is found out which comes as 13.4 months. This marginal reduction of the labour cost allows the company to be more price competent.

6. CONCLUSION

This study dealt with a Work Measurement field study conducted in an electromechanical relay manufacturing company to improve worker productivity by reducing the production time and there by labour cost through various interventions in a repetitive production task performed. The key product of the company has been identified by a pareto analysis. After identifying the key product a complete Time Study has been carried out to find out the existing times of all the assembly operations. The various improvements with regard to changing workplace layout, designing new work methods ,combining activities, Modification of tools, Allocating the workers to handle multiple equipments, implementing semiautomatic or machineries instead of manual ones, redesigning the fixtures etc have been contemplated and the effect of those changes has been quantitatively assessed by using MTM-2. Before using MTM-2 the accuracy of that is checked against the time study value in the existing company environment.

This study established Standard Time for all the operations of the key product which can be used as the basis for Cost Allocation, Developing a proper wage incentive plan, Performance evaluation of the workers, Balancing assembly lines, Production scheduling, Evaluation of alternatives etc.

Work measurement analysis in the company will help to improve the jobs and decrease the labour cost. The analysis shows a decrease of 9.92 % in the labour cost of the key product. Especially during the times of less profit a reduction in labour cost will be of paramount importance to the company. It allows the company to be more price competent. The reduction in labour cost lowers the product cost so that the price to the consumer is reduced and at the same time the employer becomes more competitive and this eventually protects the employee's job.

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