International Journal of Advance Research in Science and Engineering
Vol. No.5, Special Issue No. (02), March 2016
www.ijarse.com
IJARSE
ISSN 2319 - 8354

REVIEW ON DESIGN AND AUTOMATION OF AXLE ASSEMBLY BY USING JIG AND FIXTURE ON CONVEYOR PROCESS LINE

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ABSTRACT

This project deals with the axle assembly which used in four wheel drive and Two wheel drive (Scorpio, Xylo, Bolero etc.) .Now a days there is competition in market to make available the product in an optimum quantity and within a forecasted date with a good quality. To fulfill this condition we need to adapt new technique and eliminate Non value aided (NVA) operations. Also optimize the workplace layout. To analyze the task in the manufacturing, proper production scheduling is very important.Now the axle assembly is done manually with lower production rates than the required for company. So to increase production rate we decided to do axle assembly on conveyer. It decreases the workers Fatigue for production as well as output increases.

I. INTRODUCTION

For the improved productivity to satisfy the market demand the efficiency of Man, Machine and Methodology plays a vital role. The efficiency of man i.e. operator is highly depending on how well the workstation is designed ergonomically, whereas the efficiency of machine is more if its utilization is more and proper. But efficiency of both, i.e. Man and Machine is highly affected by methodology adopted in the manufacturing system as unnecessary and NVA and operation will cause the fatigue to operator as well as improper machine utilization. Here proper product ion scheduling is very important. To analyses the task in the manufacturing. Time study and motion study is widely used. Time study is defined as ‘ time study is a work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions, and for analyzing the data so as to determine the time necessary for carrying out the job at a defined level of performance. Motion study is defined as ‘motion study is the systematic recording and critical examination of existing and proposed ways of doing work, as a means of developing and applying easier and more effective methods and reducing costs. In this project, assembly task at one of the leading axle manufacturing company (Sharda Motor Ltd.) in India at Nashik is studied for the objective of performance evaluation of the productivity.In the primary phase the study regarding the workplace layout, no of components involved, movement of workers, available tools and their location etc. were analyzed. The motion study was

carried out for analyzing the material component flow and workers movement for the flow process charts were developed and critically examined. The stop watch technique of time study was used to determine the time required for each of the operation involved in the assembly task.We use fish bone type axle assembly arrangement system for storage.There are three types of axle assembly 4WD axle &2WD &S.C. D.C. axle for scorpio, bolero, xylo..etc. this assembly contents following major components i.e. knuckle, metal sheet, hub & disc, caliper, lower arm, upper arm,Knuckle is also divided as follow 4WD Knuckle, 2WD Knuckle , ABS Knuckle, NON ABS knuckle, S.C.D.C. Knuckle.

4 wheel drive axle assembly used for scorpio

II. HISTORY

1776, Adam Smith through his book wealth of nations laid foundations of scientific manufacturing. He organized division of labour concept, Based upon skill development time saving and the specialized machines. He influenced the industrial scenario in grate deal and contributed to achieve mass production in larger extent. His work was carried forward by Charles Babbage, an English mathematician.Fredrick W. Taylor (1859-1915) was a mechanical engineer, who implemented Smith's theories and developed scientific management. From then till 1930, many techniques were developed prevailing the traditional view. Initiated investigations of better work method and developed integrated theory of management principles and methodologies.Henry L. Gantt (1913) was an engineering contemporary of Taylor, had a profound impact on the development of management thinking and he worked in the field of motivation, developed tasks and bonus, incentive planes. He advocated measurement of management result by using Gantt Charts and proposed training of workers by management. Frank Gilbreth suggested motion study (1917) as the science eliminating wastefulness resulting from unnecessary ,ill directed and inefficient motions ,he evolved principles of motion economy .gilbert therbligs (the fundamental motions involved in doing an activity).he also developed micro motions study and SIMO analysis to office procedures and applied motion study assemble and dissemble the weapons during his service in U.S. army.

III. LITERATURE REVIEW

Gurunath and Jadhav (2012a) conducted 'Ergonomic analysis of an assembly workstation to identify time consuming and fatigue causing factors using application of motion study' and investigate lots of money on **MAN**, **MACHINE,MATERIAL, METHOD (4M),**improving ergonomics of workplaces is cost saving. Ergonomics found great need when market demand is high and manufacturers need more output within short period. This study was conducted on assembly workstation of welding shop. This work was conducted on an

assembly station in welding shop. The shop was facing problem of less efficiency of workers due to poor ergonomics and in some severe cases hazardous health issues are found. This work was conducted on an assembly station in welding shop. The shop was facing problem of less efficiency of workers due to poor ergonomics and in some severe cases hazardous health issues are found. Baba MdDeros et al. (2011) conducted 'An ergonomics study on assembly line workstation design' and suggested the concept of high demand for products in the manufacturing industry had driven the human workers to work faster and adapt to their ergonomically designed workstation.

3.1 Problem Statement:

1)Axle assembly is done manually which causes lower production rate also consume more time.

To improve productivity we use DEMING CYCLE as given below

As per deming cycle PDCA i.e. Plan-Do-Check- Act

PLAN: - For conveying operations

DO:- Design and Modifying Fixture and Material storage racks.

CHECK:-Identifies the effects due to conveying operations.

ACT:-Use of Different standardize work measurement techniques Such as MOST, ECRS for reducing idle time and improve productivity.

IV. WORK MEASUREMENT BY MOST

Maynard Operation Sequence Technique (MOST) is predetermine motion time system that is used primarily in industrial settings to set the standard times in which a worker should perform a task. To calculate this task is broken down into individual motion elements and each is assign a numerical time value in units known as time measurement units

(TMU).

Time Unit used in MOST

The time measurement unit (TMU) is used as a time unit for MOST analysis,

Which is converted to the minute by using the following Table

1 TMU	0.00001 hour
1 TMU	0.0006 minute
1 TMU	0.036 second

Basic Most: - The motions recorded in basic most are on the level of tens of TMUs(10*TMU) . basic most is used accurately for operations ranging from less than minute to above 10 minute

Mini Most: - MINI MOST uses individual TMUs& it is commonly used for short (less than about a minute), repetitive cycles .

Maxi Most: - MAXI MOST uses Hundreds of TMUs & it is used for longer (more than several minutes), Non –repetitive Operations.

Clerical Most: - It is same as BASIC MOST.

4.1 Basic Most

MOST is a work measurement technique, introduces to compile the standard work time and maximizes the resource utilization by improving the working method. Though the concept of MOST was firstly introduced by Maynard in 1960, its industrial application had started from 1967 in the form of Basic MOST. For performing the administrative and the clerical work in the production and service industries, in 1970 the Basic MOST was modified and named as

Clerical MOST. Whereas, in 1972 and 1974, the basic MOST was lunched for first time inside Sweden and United2164States respectively A part of the Basic MOST, two other widely used version of MOST namely Mini MOST and Maxi MOST were also introduced in literature in 1980 (Jamil et al. 2013). Thus three general versions of the MOST are found in literature i.e. Basic MOST, Mini MOST, and Maxi MOST. To perform a manual work, the Basic most defines a sequence of three actions namely General Move, Control Move and Tool Use which are described below.

4.1.1 General Move

The free movement of a studied object in air are explained and categorized under the General Move Sequence Model. In brief, the General Move model follows the Sequence of GET, PUT, and RETURN i.e. |A B G|, |A B P| ,and |A|. An explanation of the parameters A, B, G, and P are given in Table 1. Each of these parameters A, B, Gland P has its own index value which is determined from the MOST Data Card

Table 4.1.1: Parameters used in General Move

Notations	A	B	G	P
Description	Action Distance	Body Motion	Gain Control	Placement

4.1.2 Control Move

The movement of a studied element while it is in contact with surface or attached with other objects are explained and categorized under the Control Move Sequence Model. The control move model has sequence of GET, MOVE or ACTUATE, and RETURN phases i.e. |A B G|, |M X I|, and |A|. An explanation of the parameters A, B, G, M, X and I are given in Table 2. Each of these parameters A, B, G, M, X and I has its own index value which are determined from the MOST Data Card .ACTUATE, and RETURN phases i.e. |A B G|, |M X I|, and |A|. An explanation of the parameters A, B, G, M, X and I are given in Table 2. Each of these parameters A, B, G, M, X and I has its own index value which are determined from the MOST Data Card.

Table 4.1.2: Parameters used in Control Move

Notations	A	B	G	M	X	I
Description	Action Distance	Body Motion	Gain Control	Move Controlled	Process Time	Alignment

4.1.3 The Tool Use

During the assembly or production, the operations of hand tools are explained and categorized under the Tool UseSequence. The Tool Use model consists of a Sequence of GET TOOL, PLACE TOOL, TOOL ACTION, PLACE TOOL, and RETURN phases i.e. |A B G|, |A B P|, |U|, |A B P|, and |A|. An explanation of the parameters A, B, G, P and U are given in Table 3. For the GET TOOL phase, and the PUT TOOL phase, the index values are assigned in the same manner as the GET phase in General Move sequence model. TOOL

ACTION PHASE is considered when the operators perform the necessary tool actions. This phase includes F - Fasten, L- Loosen, C - Cut, S – SurfaceTreat, M - Measure, R- Record, and T - Think.

Table: 4.1.3 Parameters used in tool use.

Notations	A	B	G	P	U
Description	Action Distance	Body Motion	Gain Control	Placement	Tool Action

MOST ESTIMATION SHEET

SR. NO.	OPERATION	GET	PUT	CONTROLLED	RETURN	TOOL	FREQUENCY	TOTAL TMU(*10)
1	Caliper placed in caret	A1 B3 G3	A1 B10 P1	M0 X0 I0	A0	F0	1	190
2	Taper Bearing, Two lock nut and washer placed in caret	A1 B3 G3	A1 B3 P1	M0 X0 I0	A0	F0	1	120
3	Hub and disc placed in caret	A1 B3 G3	A1 B10 P3	M0 X0 I0	A0	F0	1	210
4	Sheet Placed in caret	A1 B3 G1	A1 B3 P1	M0 X0 I0	A0	F0	1	100
5	Knuckle placed on fixture	A1 B3 G3	A1 B10 P3	M0 X0 I0	A0	F0	1	210
6	sheet Align on knuckle	A1 B3 G1	A1 B10 P3	M0 X0 I1	A0	F0	1	200
7	Pick M6 bolt and Prefit on knuckle	A1 B3 G1	A1 B3 P3	M10 X10 I1	A0	F0	3	990
8	Pick runner	A1 B3 G1	A1 B0 P0	M0 X0 I0	A0	F0	1	60
9	Fitted M6 Bolt	A0 B0 G0	A0 B0 P0	M0 X3 I1	A0	F3	3	210
10	Put runner on stand	A0 B0 G0	A1 B3 P1	M0 X0 I0	A0	F0	1	50
11	Pick up Hub and Disc and Align with knuckle	A1 B3 G3	A1 B10 P3	M0 X0 I0	A0	F0	1	210
12	Pick and insert	A1 B3 G0	A1 B10 P1	M0 X0 I0	A0	F0	1	160

	Taper Bearing							
13	Pick and insert Lock-nut(without pin)	A1 B3 G0	A1 B10 P3	M0 X0 I0	A0	F0	1	180
14	Fit Lock nut with Runner	A1 B3 G0	A1 B10 P0	M3 X16 I1	A0	F6	1	410
15	Pick and insert Washer	A1 B3 G0	A1 B10 P3	M0 X0 I0	A0	F0	1	180
16	Pick and insert Lock nut (with pin)	A1 B3 G0	A1 B10 P3	M0 X0 I0	A0	F0	1	180
17	Fit Lock nut with Runner	A1 B3 G0	A1 B10 P0	M3 X16 I1	A0	F6	1	410
18	Rotate Fixture	A0 B0 G0	A0 B0 P0	M1 X3 I0	A0	F0	1	40
19	Pick and Check End Play Dial	A1 B3 G0	A1 B10 P3	M6 X3 I3	A0	F1	1	310
20	Rotate Fixture	A0 B0 G0	A0 B0 P0	M1 X3 I0	A0	F0	1	40
21	Pick and Check Run Out	A1 B3 G0	A1 B10 P3	M3 X3 I3	A0	F1	1	280
22	Rotate Fixture	A0 B0 G0	A0 B0 P0	M1 X3 I0	A0	F0	1	40
23	Pick and Locate Caliper on Hub and Disc	A1 B3 G3	A1 B10 P3	M0 X0 I0	A0	F0	1	210
24	Pick and Align M12 Bolt and Pretight	A0 B0 G0	A0 B0 P1	M10 X10 I0	A0	F0	2	420
25	Fit M12 Bolt with Runner	A1 B3 G0	A1 B10 P0	M3 X10 I1	A0	F6	2	700
26	Rotate Fixture	A0 B0 G0	A0 B0 P0	M1 X3 I0	A0	F0	1	40
27	Pick Lower arm and Place on Fixture	A1 B3 G3	A1 B10 P3	M0 X0 I1	A0	F0	1	220
28	Pick Castle Nut and Pretight	A1 B0 G0	A1 B0 P3	M1 X10 I1	A0	F0	1	170
29	Fit Castle Nut	A1 B3 G0	A1 B10 P3	M3 X10 I1	A0	F6	1	380

	With Runner							
30	Pick up Slip Pin and insert into Hole	A0 B0 G0	A0 B0 P3	M1 X0 I1	A0	F0	1	50
31	Pick Hammer and Bend Slip pin	A0 B0 G0	A0 B0 P3	M1 X10 I0	A0	F10	1	240
							TOTAL TMU	**7210**
							TOTAL TIME IN MIN	**4.326**

V. ECRS TECHNIQUE

ECRS technique:

This tool can be used for

Set up change loss reduction

Tool change loss reduction and Mean time to repair reduction

It is also used in

- Layout optimization study
- Operator work load analysis
- Process de-bottle necking
- Assembly line – time reduction
- Office TPM (Process time reduction)

  After activity mapping for set up change/tool change / Mean Time to Repair
- Use Internal & External analysis tool
- After the external / internal analysis, the time for setup will come down
- Internal time is considered as new setup time.
- This setup time contains many unwanted activity which can be considered for time reduction.
- ECRS technique is used for further time reduction

ECRS is unique approach towards process activity optimization with following core principle

5.1Elimination

Elimination of activity is the best One shot setup is idea No change over is the ultimateEliminate is a consider how the current work and eliminate waste of seven was found in manufacture such as the delay, Removing unnecessary, functions that are not beneficial, and waste.

5.2Combination -

If elimination is not possible combine the activityIt works by reducing the unnecessary step bunching together, reduce process down and production is faster. The movement during the process is down.

5.3Rearrange -

If combination is not possible Reduce the activity timeWhat is the process to reduce unnecessary movement or delay between process. For the example, we swap step 2 and step 3 for reducing distance moving.

5.4Simplification -

If activity time cannot be reduced Dokaizens to simplify the activitiesFor improving the work easier, more convenient. Sometime we design jig and fixture to help for the convenience and accuracy. Of the above, we conclude that there are several waysto reduce work time by dint of ECRS technique, motion and time study, line balancing, and activity analysis etc.

ECRS SHEET

SR.NO.	WORK ELEMEMT	WHAT	WHERE	WHEN	WHY	WHO	HOW	WORK ELEMENT	E	C	R	S
1	Pick The Knuckle From Stand			X				After caliper loading			X	
2	Load The Knuckle		X					In the bin	X			
3	Pick The Knuckle		X					From the bin	X			
4	Load The Knuckle		X					On the fixture			X	
5	Clamp The Knuckle			X				After knuckle loading			X	
6	Pick the Hub			X				After clamping knuckle			X	
7	Load the hub		X					In the bin	X			
8	Pick the hub		X					From the bin	X			
9	Pick the dustshield			X				Along with hub		X		
10	Load the dustshield		X					In the bin	X			
11	Align hub mounting holes with dust shild mounting holes			X				After picking up hub &dustshield			X	
12	Assemble hub sub assy(with dust shield)		X					On the knuckle			X	

13	Turn back clockwise & move 2 steps towards disc stands			X				At the start of 3rd station			X	
14	Pick the disc with both hands			X				After previous			X	
15	Turn back clockwise & move 2 step towards conveyer			X				After previous			X	
16	Load the disc		X					Into kitbin	X			
17	Pick the disc		X					From bin	X			
18	Pick bar code sticker from sticker stand with RH			X				Along with part no code in LH		X		
								TOTAL	**7**	**2**	**9**	**0**

VI. DESIGN OF FIXTURE

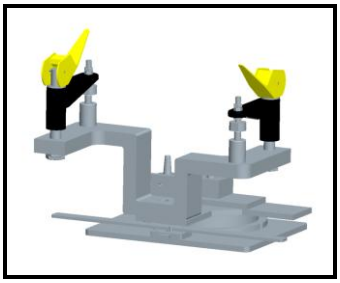

Fig 6.1: Design of Fixture

VII. RESULTTABLE

SR.NO.	PARAMETERS	BEFORE	AFTER
1	Number of activities	40	31
2	Cycle Time(in min)	10.42/piece	4.326/piece
3	Weight Lift By Knuckle	35Kg	12.5Kg
4	Number of bends	13	9
5	Number Of Steps	4	7
6	Torque accuracy	±30%	±10%
7	Productivity	92	220

VIII. CONCLUSION

It is evident that to sustain in this competitive industrial environment, a company needs to reduce or eliminate the idle and/or down time, improve the working methods, standardize the time as well as enhance the overall capacity planning and in this respect the MOST can play a vital role.

By using MOST wedecrease time & man power improve productivity.

By using ECRS we combine two types operation on same fixture

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