© 2017 IJEDR | Volume 5, Issue 1 | ISSN: 2321-9939

Implementation of pneumatics on welding fixture assembly system to increase productivity

Suyog Pradip Joshi, Subodh Sunil Kale
Department of Mechanical Engineering,
Sir Visvesvaraya Institute of Technology, Nashik, Maharashtra, India.

***Abstract*—CG220N is the inner metallic part, which is situated at the plenum windshield section of windshield of Scorpio, a four-wheeler categorized in SUV or as pick-up truck. In Mahindra CIE Automotive Nasik Welding of CG220N takes place at the sub assembly shop. The CG220N part is the product of welding together two parts CG410 and CG730. Resistance Spot Welding (RSW) is used to weld them. The existing method to weld them together is by clamping them together on the welding fixture assembly system. Aim of this Project is to improve the overall system by implementation pneumatics and decrement in cycle time. The existing hand clamp system is replaced by pneumatic clamp system. This change will bring out reduction in cycle time hence increase in productivity. Also it is observed that Operator Fatigue is reduced.**

Keywords—Cycle Time, pneumatics, weld fixtures, Time Study.

I. INTRODUCTION

This project mainly revolves around the assembly of component 0101CG0220N. For sake of convenience let's say CG220N. CG220N is the inner metallic part, which is situated at the plenum windshield of Scorpio, a four-wheeler categorized in SUV or pick-up truck. This component is addition of two other parts CG410N and CG230N. Both of the components are welded together for formation of complete CG220N. As shown in Figure.1. The welding process is done manually. The type of welding technique used is spot welding, with the help of a spot gun. The operator places CG410N on CG230N, and fixes them accurately with fixtures on which hand clamps and locating pins are installed.

Fig.1 CG410 and CG230

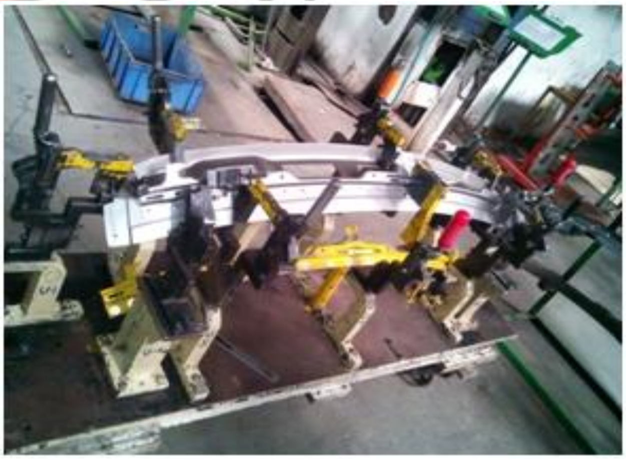

Fig.2 Assembled CG220N

What makes CG220N different from other components manufactured at Mahindra CIE is its curve design, and thus makes it exceptional. The existing fixture mechanism in the company is also based on application of human efforts that is use of manual operated clamps with locating pins.

II.PROBLEM STATEMENT

- Process based: The complete process takes specific time, starting from picking up separate parts from rack, fixing them up, welding them together, and keeping them back to the rack. This cycle time in the existing system is quite large than expected, which leads to reduced economic loss, decreased productivity.
- Operator based: The Operator working on this system suffers fatigue, due to tightness of hand clamps, and continuous locking and unlocking of clamps.

III.CYCLE TIME ANALYSIS

To understand the entire work flow, the work stages of the operator are broken to small fragments. Cycle time is the time required for the entire process to get completed. Cycle time study is carried to check where unnecessary time is getting consumed. Our Aim is to reduce this time to possible extent. The Operator works in 8 hours shift.

8 hours of shift = 8×60= 480 minutes.

Lunch Break = 30 minutes.

Tea break = 10 minutes.

Personal Allowance = 5% of total time = 0.05×480 = 24 minutes.

Thus the Operator works for 480 − (30+10+24) = 416 minutes on the welding fixture assembly system.

Thus the total productive time in 1 shift is **416 minutes**.

Table.1 Cycle Time Study

	Total number of spot welds on assembly	33
	Operation Name	**Existing Time in seconds**
1	Weld time taken for each spot	2 seconds
2	Total Time taken for spot welding	66 seconds
3	Total Loading and Unloading Time	30 seconds
4	Opening and closing of hand clamps	20 seconds
5	Positioning of weld gun	20 seconds
6	Time taken for welding a single assembly	135 seconds = 2.26 minutes

From Table.1 We can calculate,

Number of assemblies welded in a shift = 416/2.26 = **184 assemblies**.

Thus in the existing system with hand pushed lever clamps, 184 assemblies/shift are obtained.

IV. PROCESS NEED

For increment in productivity, our target is **206 assemblies per shift**. Let X be the time in minutes for 1 assembly, when the target is set for 206 assemblies per shift.

For 416 minutes --------->206 assemblies

Then X minutes ---------> 1 assembly

Therefore **X = 416/206 = 2.02 minutes = 121 seconds**

Hence in order to obtain 206 assemblies we have to complete the process in 121 seconds. This can be achieved by reducing the time in opening and closing of hand clamps. Also the Operator Fatigue is reduced due to elimination of hand clamps.

V. SOLUTION

Implementation of pneumatic clamps in place of conventional manually operated push rod lever clamps is solution to increase the productivity and reduce the operator fatigue in case of this project. In order to install pneumatic clamps, it is necessary to calculate pneumatic cylinder diameter that would be suitable for our system. Pneumatic systems manufacturer which provide pneumatic clamps to Mahindra CIE is SMC Pneumatics.

Factors to be considered for design of pneumatic cylinder:

a) Cylinder Thrust:

Cylinder thrust is a function of Piston diameter, applied air pressure, Frictional resistance (efficiency). Required cylinder thrust is generally derived from a known clamping pressure (static) .To determine the correct size of cylinder; it is necessary to use the formula:

Thrust = Pressure × Area × Efficiency

b) Available Air Pressure:

Pressure in this instance being the available air pressure is expressed in units of bar

c) Frictional Resistance:

Cylinder efficiency also known as Frictional Resistance varies between manufacturers, being dependent upon both cylinder construction and the seal technology employed. The general efficiency of cylinders designed with lip seals is considered to be 80% whilst more sophisticated and technologically advanced designs can be as high as 90%.

Calculations: 1) Operating Pressure (p)
2) Piston diameter (D)
3) Piston Area (A)
4) Piston Force (f)
5) Frictional Resistance (R) ~10%f
6) Effective Piston Force (F)

From given industrial standards of Mahindra CIE: $p = 6 \text{ bar} = 6\times10^5 \text{ N/m}^2$

After observing other pneumatic systems in Mahindra CIE, Assuming cylinder diameter (cylinder bore) = 63mm = 0.063m.

From formula by manufacturer: $\mathbf{F = p \times A - R}$

$= f - R$

$= 6\times10^5 \times (\Pi\times0.063^2/4) - 0.10f$

$= 1870.34 - 0.10\times1870.34$

Effective Piston Force = **1683.30N**

And according to given standards of manufacturer company SMC Pneumatics. A pneumatic clamp of above mentioned specification is available, as shown in fig.3.

Piston force [N]								
Ø	Operating pressure [bar]							
	1	2	3	4	5	6	7	8
2.5	0.4	0.9	1.3	1.8	2.2	2.7	3.1	3.5
3.5	0.9	1.7	3.8	3.5	4.3	5.2	6.1	6.9
5.35	2	4	6.1	8.1	10.1	12.1	14.2	16.2
6	2.5	5.1	7.6	10.2	12.7	15.3	17.8	20.4
8	4.5	9	13.6	18.1	22.6	27.1	31.7	36.2
10	7.1	14.1	21.2	28.3	35.3	42.4	49.5	56.5
12	10.2	20.4	30.5	40.7	50.9	61.0	71.3	81.4
16	18.1	36.5	54.3	72.4	90.5	109	127	145
20	28.3	56.5	84.8	113	141	170	198	226
25	44.2	88.4	133	177	221	265	309	353
32	72.4	145	217	290	362	434	507	579
40	113	226	339	452	565	679	792	905
50	177	353	530	707	884	1,060	1,240	1,410
63	281	561	842	1,120	1,400	1,680	1,960	2,240
80	452	905	1,360	1,810	2,260	2,710	3,170	3,620
100	707	1,410	2,120	2,830	3,530	4,240	4,950	5,650
125	1,100	2,210	3,310	4,420	5,520	6,630	7,730	8,840
160	1,810	3,620	5,430	7,240	9,050	10,900	12,700	14,500
200	2,830	5,650	8,480	11,300	14,100	17,000	19,800	22,600
250	4,420	8,840	13,300	17,700	22,100	26,500	30,900	35,300
320	7,240	14,500	21,700	29,000	36,200	43,400	50,700	57,900

Figure.3 SMC Pneumatic Standards

Detailed specifications of pneumatic cylinder as follows:

1. Manufacturer: SMC Pneumatics
2. Model Series : CKG1B63-100YZ
3. Category: Double acting
4. CKG1: Part Family
5. B - Clevis Width =19.5mm
6. Bore Size = 63mm
7. Stroke length = 100mm
8. Maximum Operating Pressure = 1.0MPa

VI. IMPLEMENTATION

The Pneumatic System was accepted and implemented by industry. As shown in figure.5. 6 out of 8 hand clamps were replaced by Pneumatic Clamps. Remaining 2 hand clamps were not replaced and kept as it is considering their distance from the locating pins.

Fig.4 Pneumatic cylinder of calculated Specification

Fig.5 Pneumatic clamps mounted on welding fixture system

VII. RESULTS

1) Time study was carried out for both before and after implementation of pneumatic clamps; the study was carried out for formation of 20 assemblies keeping the all other conditions same.

Table.2 Observations in cycle time

Number of assembly	Time in seconds before implementation	Time in seconds after implementation
1	135	120
2	133	123
3	134	122
4	136	121
5	137	119
6	134	122
7	135	121
8	132	123
9	133	122
10	135	121
11	137	123
12	132	122
13	131	121
14	132	121
15	134	122
16	135	121
17	136	123
18	135	122
19	131	122
20	132	121

2) According to the observations from Table.2 it is evident that maximum time operator took for completion of single assembly when hand clamps were mounted on the welding fixture was 137 seconds. But this time was drastically reduced to 123 seconds after replacing hand clamps with pneumatic clamps.

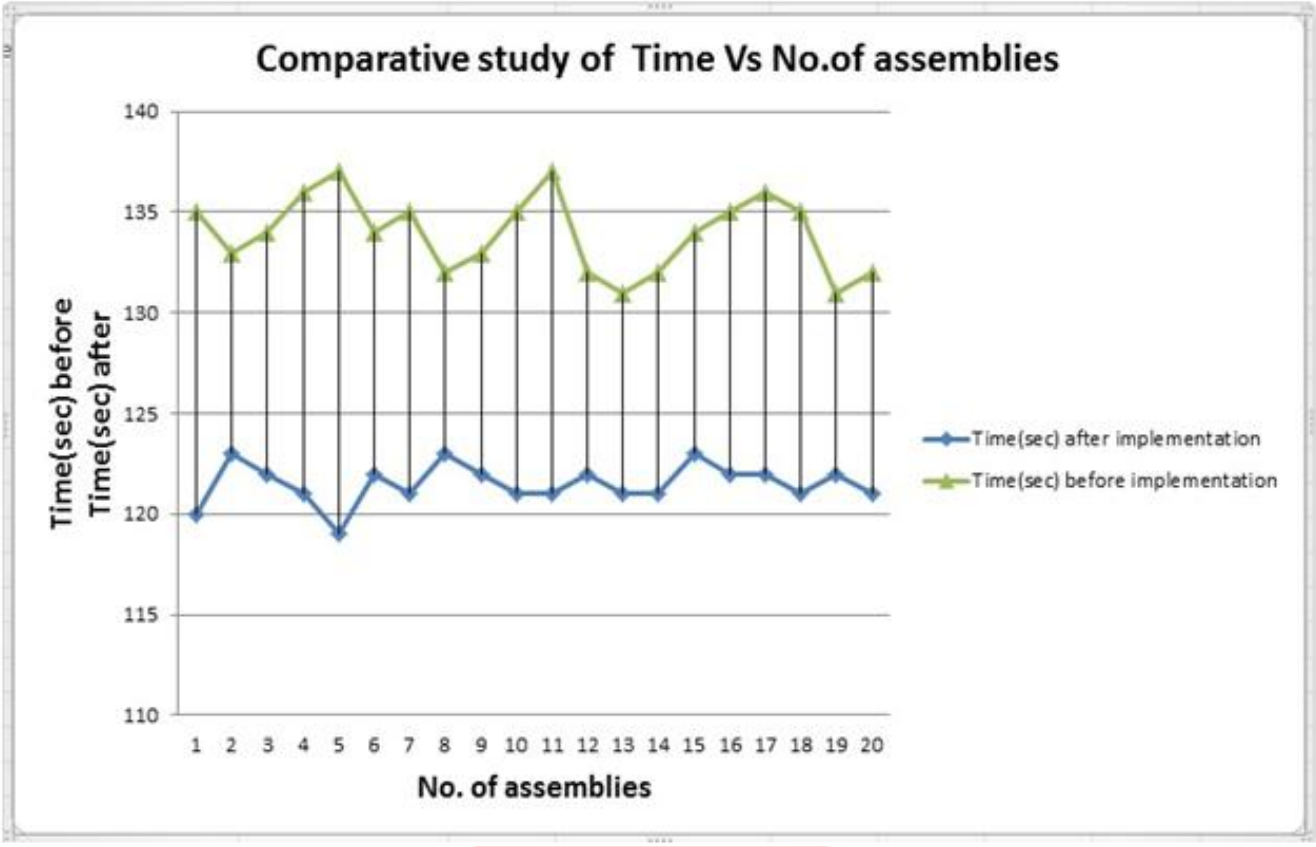

Fig.6 Comparative analysis of cycle time before and after implementation of pneumatics

3) The time taken by the operator for loading and unloading of CG410, CG730 and CG220N along with opening and closing of clamps was reduced, which is the major cause for decrement in cycle time.

VIII. CONCLUSION

After Implementation of Pneumatic clamps, the cycle time has reduced to a major extent. This Reduction in Cycle Time has improved the productivity of the system. The average time obtained after implementation of pneumatics is 122 seconds, which is the required time for achieving our target hence assembling of 206 assemblies, is possible. Implementation of Pneumatics has also reduced the Operator Fatigue, due to elimination of hand clamps.

ACKNOWLEDGMENT

The authors are grateful to the Management of Mahindra CIE Automotive Pvt. Ltd for providing permission to carry out the work. Sincere thanks are also due to Mr. Raju Jagtap, our industry project guide for helping our team in the Shop floor. The authors also thank our Head of the Department of Mechanical Engineering Prof. Saurabh Kerhalkar and our college project guide Prof. V.S Thete for their help in research assistance.

REFERENCES

[1] Shailesh Pachbhai, Laukik P.Raut, "A Review on Design of Fixtures", International Journal of Engineering Research and General Science Volume 2, Issue 2, Feb-Mar 2014.

[2] National fluid power association, Handbook for pneumatics, © Copyright 2011 Bimba Manufacturing Company. RH-112 Effective January, 2012.

[3] Parker Automation, Manual for Pneumatics Series P1E - Lightweight Design -32 mm through 100 mm ISO Pneumatic Cylinder.

[4] S. Santosh Kumar and M. Pradeep Kumar, "Cycle time reduction of a truck body assembly in an automobile industry by lean principles", International Conference on advances in Manufacturing and Materials Engineering, AMME 2014.

[5] Cristian Gelmereanua, Liviu Morara, Stefan Bogdan, "Productivity and Cycle Time Prediction Using Artificial Neural network", Procedia Economics and Finance 15 (2014) 1563 – 1569.

[6] D. Schrötera, P. Kuhlangb, T. Finsterbuschb, B. Kuhrkea and A. Verlc, "Introducing process building blocks for designing human robot interaction work systems and calculating accurate cycle times", 6th CIRP Conference on Assembly Technologies and Systems (CATS), Procedia CIRP 44 (2016) 216 – 221.