DESIGN AND IMPLEMENTATION OF COMBINED FIXTURE FOR PRODUCTIVITY ENHANCEMENT, MAN POWER AND CYCLE TIME REDUCTION IN HORN MANUFACTURING INDUSTRY ASSEMBLY LINE

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ABSTRACT

The main aim of this study is to improve the productivity and reduce the cycle time in assembly line in a horn manufacturing industry using special fixture to combine the different processes. Existing production rates and cycle times for different processes like gasket selection, pre horn assembly, horn side screw tightening, and horn pre tuning and mounting bracket assembly are noted. New special fixture with multiple tools was designed and introduced to minimize the cycle time, manpower and maximize the productivity at horn assembly line. After this special fixture design at horn assembly line, multiple processes are combined as single process with the help of special fixture. After the successful implementation of the special fixture, again the production rates, man power utilization and cycle times for the combined processes are noted. Differences in production rate, cycle time’s for different operations and man power utilization for existing fixture and special fixtures were compared with observed numerical data’s. The comparisons reveals that the implementation of the special fixture in the horn assembly line is significantly improves the productivity, minimizes the cycle times and man power utilization.

Keywords: Productivity improvement, cycle time reduction, special fixture, horn manufacturing industry.

INTRODUCTION

Production is any process or procedure developed to transfer a set of input into a specified set of output in proper quality and quantity thus achieving the objectives of an industry. Production helps to create products by the transformation of raw materials [1]. Productivity is the ratio between output of wealth and the input of resources used in the process of production [2]. Productivity measurement turns a comparison of outputs to inputs normally by calculation of a productivity index [3]. Productivity can be used to measure the extent to which a certain output can be extracted from a given input [4]. Productivity measurement is the important for any kinds of industry. Increasing productivity is one of the major issues for enhancing more profit from same kinds of resources. Productivity improvement helps to satisfy customer and reduce time and cost to develop, produce and deliver products [5]. Productivity includes effective relationship to performance measure for method utilization, method output, product prices, and work in process inventory levels and on time delivery [6]. Productivity is considered to be a growth of profit [7]. Productivity improvement can be done by sorting of elimination, repairing of ineffective process, simplifying the method, optimizing the system, reducing variation, maximizing turn out quality or responsiveness and reducing set-up time. Productivity can be also achieved by increasing the value-added content of products [8], or by decreasing the unit cost of production or decreasing the work content of the production, or line balancing of the production line or by a combination of all [9,10]. Productivity improvement is the continuous improvement process of any types of activities [3,11]. In this study, productivity enhancement, man power and cycle time reductions was gained through reducing work content by implementing using special fixture in assembly line of a specific horn manufacturing industry.

2. Observations and Problem Identification

The assembly line of smartone horn and all the stations in this assembly line were observed. In this observation, all stages cycle time was collected. From this data, some cycle time variations are having this assembly line. Diode continuity clamping voltage checking section takes less time for operation, so it may cause increased stock to the next stage. Terminal riveting and tuning screw insertion station takes normal cycle time for the operation. So that the investigation made on that two stations to combine in to a single station. In terminal riveting station, placing the window plate in the fixture for to fix the position of point holder manually it may take more time, increased hand movement, to eliminate such a time-consuming process. The windows plate can be fitted in an upper fixture permanently. In this smartone horn assembly line, terminal riveting and tuning screw insertion process has done in a normal manner. But the next stage diode continuity clamping voltage checking process is done in a faster...
manner because it takes less time for operation. This problem directly affects the take time of the assembly line. This leads to increase stock to the next station, for eliminating one man power combining two stations are combined as a single station.

3. **Problem Solving Approach**

Problem solving is the method of finding the solution for the problem to be rectified. There are various problem-solving techniques in which the suitable method can be implemented based on the problem. In this research 7QC problem solving approaches like, theme selection, current status grasping and goal setting, establishment of activity plan, cause analysis, counter measure examination and implementation, assessment of effectiveness, and standardization was used.

4. **Production Process at Assembly Line**

From the above list of problems that we identified at assembly line smart one horn, the problem of disruption in productivity at the window plate fixing in terminal riveting stage is due to the manual operation. This consumes more time and decrease in productivity. Due to the faster process increase the idle time of operator in diode continuity clamping voltage checking stage. It may end up in causing more output stock for upcoming stages. The assembly line smartone is considered for solving the problem. In this assembly line, the first initial stage spool holder riveting, involves spool assembly, spool holder and rivet are assembled in the housing. The next stage involves the assembling of terminal diode, terminal base, and point plate and point holder parts onto the housing of the horn. The next stage involves the riveting of terminal base and the tuning screw insertion. Then the next stage used for checking the voltage of diode continuity. Hand movement for placing the window plate in the housing for adjusting the position of point holder extending the time consumption of particular operation. It leads to loss of production; more cycle time and extra man power is needed. Because of the less work and more idle time in the diode continuity voltage checking operation may cause sudden large work load for the upcoming process which is to be done in a same assembly line. Observations were done to identify if the problem really existed and the data was collected.

- Available hours per shift = 8 hours
- Target of the assembly line = 1400 No’s
- Average time of each component = 19.28 seconds.

5. **Existing methodology**

Adjusting the point holder position is done manually. This process is made only after the completion of previous process. Placing the windows plate is made by excess of hand movement of individual operator and it consume more time.

6. **Proposed methodology**

The objective of the process is to eliminate the excess hand movement for the operation. Unique type of fixture is designed for the corresponding terminal riveting process. A process of window plate is to adjust the position of point holder in the housing assembly during riveting. Fixture is made with provision for low and high models. The fixed window plate made with permanent position in upper fixture of terminal riveting fixture (hydro pneumatic press). When the process is started upper fixture move down and it will do both the riveting and position adjusting of terminal base and point holder. The three dimensional model of existing and proposed fixture is shown in figure.1.

6.1 **Interference of theoretical cycle time calculation**

- Available hours per day (shift) = 8 hours
- Available time in minutes = 8*60 = 480 minutes
- Less recess time in minutes = 480-30 minutes = 450 minutes
- Available time in seconds = 450*60 = 27000 seconds
- Actual cycle time = 27000/target = 17.55 sec
- Target predefined = 1400
- Actual time = 19.28 seconds.
- Cycle time for terminal base riveting and tuning screw insertion = 18.76 sec
- Time consume for manual windows plate process = 1.21 sec
- Actual time after eliminating the manual process = 17.55 sec
- Actual time = 27000/target = 17.55 sec
- Target obtained= 1538 No’s
- Difference = 138 products.

![Figure 1 (a) Existing fixture (b) & (c) Combined fixture](image)

The cycle time comparison of terminal base riveting process for individual fixture and combined fixture is shown in figure.2 (a). The comparison show that the implementation of the combined fixture in the horn assembly line is reduces the cycle time for riveting process from 10.41 seconds to 9.57 seconds respectively.

![Figure 2 Cycle time for (a) Terminal base riveting process (b) tuning screw insertion process](image)
6.2 Productivity Enhancement in Combining the Two Fixtures

From the above list of problems that we identified at assembly line smartone, the problem of disruption in productivity at terminal base riveting fixture – tuning screw insertion machine. This consumes more time and decrease in productivity. The assembly line of smartone is considered for solving the problem. In this assembly line, the first initial stage spool holder riveting, involves spool assembly, spool holder and rivet are assembled in the housing. The next stage involves the assembling of terminal diode, terminal base, and point plate and point holder parts onto the housing of the horn. The next stage involves the riveting of terminal base and the tuning screw insertion. Then the next stage used for checking the voltage of diode continuity. Riveting process is accomplished with single hydro pneumatic where the screw insertion is not included, which consume time. Then screw insertion process is made completely separate machine and it’s transferred to diode continuity voltage checking stage. This cause loss in productivity. Observations were done to identify if the problem really existed and hence data was collected.

- Available hours per shift = 8 hours
- Target of the assembly line = 1400 No’s
- Average time of each component = 19.28 seconds

6.3 Existing methodology

After completing the terminal base diode, point plate and point holder assembly. The product reaches the terminal base riveting stage. In this process riveting is done with hydro pneumatic terminal riveting fixture it consumes more time.

6.4 Proposed methodology

The objective of this process to reduce the time consumption in terminal base riveting fixture. Combined form of terminal riveting fixture is designed with screw insertion method in to single stage. In this stage the development is approached by combining two stages. When the housing assembly is placed in fixture, upper fixture moves down both the r...
The comparison shows that the implementation of the combined fixture in the horn assembly line reduces the cycle time for riveting process from 8.57 seconds to 7.59 seconds respectively. The cycle time comparison of diode continuity voltage process for individual fixture and combined fixture is shown in figure 5 (b). The comparison reveals that the implementation of the combined fixture in the horn assembly line reduces the cycle time for tuning screw insertion process from 10.54 seconds to 9.25 seconds respectively. The total cycle time for tuning screw insertion process and diode continuity voltage process for individual fixture and combined fixture is shown in figure 6 (a). The comparison illustrates that the implementation of the combined fixture in the horn assembly line reduces the total cycle time for both tuning screw insertion process and diode continuity voltage process from 19.11 seconds to 17.23 seconds respectively. The productivity comparison between the existing method (manual fixing) and proposed method (combined fixture) is shown in figure 6 (b). It demonstrates that the accomplishment of combined fixture in the horn assembly significantly improves the productivity from 1400 No’s to 1573 No’s per shift.

6.6 Productivity enhancement after combining two stages

The problems that are identified at assembly line of smartone are disruption in productivity at tuning screw insertion machine – diode continuity clamping voltage checking. This consumes more time and decreases productivity. In this stage screw insertion process is made completely separate machine as mentioned in previous chapter where leads to more time consuming and increased hand movement and it’s transferred to diode continuity voltage checking stage, this causes a loss in productivity.

6.7 Existing methodology

After completing the terminal riveting, the product reaches to the diode continuity voltage checking stage. In this process voltage checking is done with diode continuity voltage fixture it consumes more time.

6.8 Proposed methodology

The objective of this process to reduce the time consumption at diode continuity voltage checking stage. Combined form of diode continuity voltage fixture with screw insertion method in to single stage is designed. In this stage the development is approached by combining two stages. When the housing assembly is placed the upper fixture moves down both the voltage checking and screw insertion method done in this single stage.

6.9 Inference of theoretical cycle time calculation

- Available hours per day (shift) = 8 hours
- Available time in minutes = 8*60 = 480 minutes
- Less recess time in minutes = 480 - 30 minutes = 450 minutes
- Available time in seconds = 450*60 = 27000 seconds
- Actual cycle time = 27000/target
- Target predefined = 1400
- Actual time = 19.28 seconds.
- Cycle time for tuning screw insertion = 8.57 sec
- Cycle time for diode continuity voltage checking = 10.54 sec
- Total cycle time = 19.11 sec
- Time reduced after combining the two stages = 1.71 sec
- Saved time = 19.28 - 19.11 = 0.17 + 1.71 = 1.88 sec
- Actual time after combining two stages = 17.23 sec
- Actual time = 27000 / target = 17.23 sec
- Target obtained = 1567 No’s
- Difference = 167 products.

The cycle time comparison of tuning screw insertion process and window plate fixing process for individual fixture and combined fixture is shown in figure 7 (a). The comparison shows that the implementation of the combined fixture in the horn assembly line is reduces the cycle time for tuning screw insertion and window plate fixing process from 1.21 seconds to 0.5 seconds respectively. The total cycle time comparison of tuning screw insertion process and window plate fixing process for individual fixture and combined fixture is shown in figure 7 (b). The comparison reveals that the implementation of the combined fixture in the horn assembly line is reduces the cycle time for tuning screw insertion process and window plate fixing process from 18.76 seconds to 17.55 seconds respectively.

Figure 5 (a) Cycle time for (a) tuning screw insertion process (b) diode continuity voltage process

Figure 6 (a) Total cycle time for tuning screw insertion process and diode continuity voltage process (b) productivity at smart one assembly

Figure 7 Tuning screw insertion process and window plate fixing process (a) cycle time (b) total cycle time

The productivity comparison between the existing method (individual fixture) and proposed method (combined fixture) is
shown in figure.8 (a). It demonstrate that the accomplishment of combined fixture in the horn assembly is significantly improves the productivity from 1400 No’s to 1567 No’s per shift.

Figure 8 (a) Productivity at smart one horn assembly (b) percentage of cycle time reduction

The percentage of cycle time reduction in all processes at smart one horn assembly line is shown in figure.8 (b). It shows that the combined fixture usage at smart one horn assembly line is reduces the 6.88% of cycle time for tuning screw insertion process, 12.43% of cycle time for diode continuity voltage process, 9.55% of cycle time for both tuning screw insertion process and diode continuity voltage process. Similarly the implementation of combined fixture is reduces the 58.17% of cycle time for windows plate fixing process respectively. The percentage of improvement in productivity at smart one assembly line in horn manufacturing industry is shown in figure.9. It exhibits that the usage of combined fixture is improves the productivity of 12.35% in terminal base riveting and tuning screw insertion process.

Figure 9 Percentage of productivity improvement for all processes at smart one horn assembly line

The combined fixture implementation also improves the productivity of 11.92% in tuning screw insertion and diode continuity voltage checking process. The combined fixture enhances the productivity of 9.85% in windows plate fixing process significantly.

CONCLUSION

The combined fixture was designed and implemented to reduce the cycle time, man power and improve the productivity at assembly line in a leading horn manufacturing industry. The considerable outcomes are observed by comparing the data collected from existing fixture and combined fixture. The implementation of special fixture is significantly improves the production quantity per shift for different horn assembly process like tuning screw insertion, window plate fixing, diode continuity voltage process and terminal base riveting and tuning screw insertion process respectively. The implementation of special fixture is also considerably reduces the total cycle time and also enhances the productivity for various processes at assembly line in horn manufacturing industry.

REFERENCES


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