International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

Investigation of Automation strategy and its effect on Assembly cost: A case study on Power Switch Assembly

Gopal Parmar†* and Saurin Sheth†

†Mechatronics Engineering Department, G.H. Patel College of Engineering and Technology, Vallabh Vidyanagar 388120, Gujarat, India

Accepted 28 Nov 2015, Available online 08 Dec 2015, **Vol.5, No.6 (Dec 2015)**

Abstract

Automation is used to improve the productivity in majority of the industries. It helps in reducing the human intervention and improves a quality lot. Now, which process is to be automated, there is always a trade-off between initial cost and production cost. Assembly process along with the manufacturing of each part needs to be studied, to automate the desire manufacturing processes. Here a case of power switch is investigated and analysis is carried out in terms of the Automation strategy. Each process is analysed by parameters like efficiency, Accuracy, lead time, investment cost, productivity, capacity and running cost. The analysis suggests which process needs to be automated. Later on by seeing the physibility and by using mechatronics approach one can automate the required process.

Keywords: *Power switch assembly, Automation, assembly cost, Case Study, Special Purpose Machine, Mechatronics.*

1. Introduction

Manufacturing companies continuously do effort to increase productivity and to reduce the manufacturing cost of their products. Productivity is defined as the ratio of aggregate output and aggregate inputs that are transformed into valuable output in a production process. Various concepts like JIT and Lean Manufacturing (Chauhan, *et al*, 2015) are used to improve the productivity. One of them is a Concept of Just in Time (JIT) Manufacturing uses a systems approach to develop and operate a manufacturing. JIT exceeds the concept of inventory reduction system (Chauhan and Sheth, 2014). Productivity measures the relationship between outputs such as goods and services product, and inputs that include labour, capital, material and other resources. The productivity can be improved for instance by reducing the labour content of the process, this would help to reduce the manufacturing cost of their products (Gajjar and Sheth, 2014). Nowadays the use of special purpose machine is widely adopted to increase the productivity. A stir up bending machine is developed to increase the efficiency of the stir up during construction phase (Virani, *et al*, 2013). A special purpose machine is proposed for manufacturing of a large turbine bearing (Desai and Sheth, 2015). The modelling of the machine has been carried out (Desai and Sheth, 2012). A conventional radial drilling machine is automated using mechatronics approach to rise the productivity in context of drilling of holes at Pitch Circle Diameter (Barad, *et al*, 2009). Welding industries are also acquainted with automation for complex shape of welding. A welding positioner is modelled along with the use mechatronics up to the range of 2000 kg weight object (Vaghasiya, *et al*, 2014). A SPM is designed and modelled for welding of shell- diaphragm welding in conveyor pulleys. It is capable of handling various sizes of pulley (Gangadia, *et al*, 2014). Industries established earlier were using material handling systems which were time consuming, less efficient, needed more manpower, which ultimately affects productivity. To overcome these demerits, industries needed an efficient system which can be automatically controlled (Parikh, *et al*, 2013).Product assembly is generally the largest single cost element of production manufacturing. It has been estimated to account that 50 per cent of manufacturing cost can employ more than 40 per cent of workforce in order to increase productivity (Boothroyd and Dewhurst, 1987). In the present scenario, time constrain is a crucial part for completion of any production process. Thus with the aid of automation, the production time can be reduced as well as higher degree of accuracy can be achieved as the human efforts will be alleviated (Patel, *et al*, 2015).

Nowadays various automation techniques are being adopted and researched on for increase in productivity, for better accuracy, eliminating the human errors and for safety. Machine vision (Gupta, *et al*, 2014) is one such tool which may be useful for the

*Corresponding author **Gopal Parmar** is a PG Student and **Saurin Sheth** is working as Associate Professor

advancement of automatic systems. It performs the task that are equivalent to human vision (Sheth, *et al*, 2010). It may be used for sorting of various sizes and colours (Chauhan V., *et al*, 2011).

2. Process description of Assembly line

Power switch, the most demanding product, making process consists of several operations. It starts with raw material then cutting operation, slotting, drilling, and last one threading. Power switch assembly process consists of following operations as shown in figure1.

Figure.1 Flow chart of Power Switch assembly

Power switch assembly starts with drawing a raw material of Brass rod. It contains several sub assembly process like cutting a piece from a Brass rod then making a slot on the Brass further drilling the piece of brass and lastly threading a hole in the work piece. Each process requires man and machine power to support the assembly line, but it includes such processes where optimisation can be done and the time can be decreased so that the overall cost of the product can be reduced. Manufacturing companies continuously effort to increase productivity and reduce the manufacturing cost of their products.

Operation cost (in percentage) associated with each process of switch assembly line is given in form of pi-chart as shown in figure2. The figure below shows the time taken by different phase of the process, so that we can analyse which process can be optimised. The cutting phase is complex and time consuming, so we do some automation which will reduce time and increase productivity. At present only two "to drill on work piece of Brass and threading in Hole on work piece" processes are done automatically and automatic machines are available for this process. Other than this process are done manually.

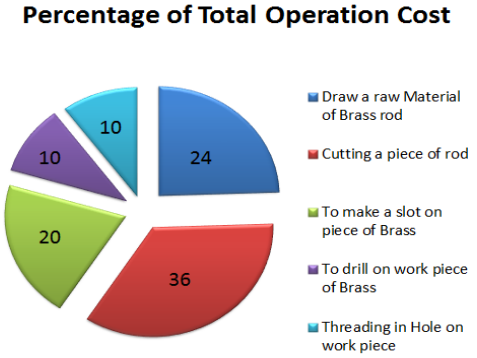

Figure.2 Total operation cost

3. Analysis of power switch Assembly process

We analysed each and every process with various parameters such as efficiency, accuracy, lead time, investment cost, running cost, capacity and productivity. Here + sign shows that favourable parameter and ++ sign indicate strongly favourable parameter and – sign shows that unfavourable parameter and last – sign indicate for strongly unfavourable parameter. At the end of each process total number of + and – are calculated for both manually and automatic method. The analysis of each process given below.

3.1 Draw a raw material of Brass rod

Table 1 Analysis for Draw a raw material of Brass rod

Affecting Parameter	Manually	Automatically
Efficiency	++	++
Accuracy	+	+
Lead time	–	+
Investment cost	++	––
Productivity	+	++
Capacity	+	–
Running cost	+	–
Sum	8+/ 1–	6+/4–

Draw a raw material of brass rod is the simplest process which is done manually. The above table 1, shows the results of machining which proves that manual machining is more beneficial than automating it. To sum up we should use the present manual process to do the above process.

3.2 Cutting a piece of rod

In Fig 3 shows that cutting operation, there are in manual process some limitation occurs like cutter would change at every 2 or 3 hours and also there is no repeatability of cut pieces because it's a dependent on labour so we would like to convert manual process into automatic process.

Figure.3 Cutting operation

Table 2 shows that, Manual process of cutting of Brass rod, here the parameter as productivity and efficiency are low and accuracy is moderate as compare to Automatic process. While in case of Automatic process, Accuracy of work piece is perfect because at fix distance rod is passing by holding pedal to the sensor then cutter would cut the rod. Also running cost of Automatic process is quite low compare to manual process.

Table 2 Analysis for cutting a piece of rod

Affecting Parameter	Manually	Automatically
Efficiency	−−	++
Accuracy	−	++
Lead time	+	−
Investment cost	++	−
Productivity	−−	++
Capacity	−	+
Running cost	++	−−
Sum	5+/6−	7+/4−

3.3 To make a slot on piece of Brass

Table 3 Analysis for to make a slot on piece of Brass

Affecting Parameter	Manually	Automatically
Efficiency	+	−
Accuracy	++	−−
Lead time	+	−
Investment cost	−	+
Productivity	−	+
Capacity	−	+
Running cost	+	−
Sum	5+/ 3−	3+/5−

Figure.4 Slotting operation

Figure 4 shows this process is simple. There is a labour put piece of brass on rotating disk then to making slot on work piece through cutter. There are owing to sum of all affecting parameter, then finally result come out manual process is more favourable compare than automatic so manually as it is.

3.4 To drill on work piece & Threading in a hole

Figure 5 show the two operations "to drill on work piece" and "threading in hole". These two processes are already automated on same machine set up (Gajjar and Sheth, 2014). The analysis of all affecting parameter are shown in table 4 & 5. As a result of automatic process sum of all parameter are more favourable. So both processes should be recommended as automatic processes.

Figure.5 Drilling and Threading operation

Table 4 Analysis for to drill on work piece of Brass

Affecting Parameter	Manually	Automatically
Efficiency	−−	+
Accuracy	−	+
Lead time	+	−
Investment cost	−	++
Productivity	−	++
Capacity	+	−
Running cost	++	−−
Sum	4+/ 5−	6+/4−

Table 5 Analysis for Threading in hole on work piece

Affecting Parameter	Manually	Automatically
Efficiency	−−	+
Accuracy	−	+
Lead time	+	−
Investment cost	−	++
Productivity	−	++
Capacity	+	−
Running cost	++	−−
Sum	4+/ 5−	6+/4−

Conclusion & Future Scope

In the present paper the automation strategies are discussed for each process of power switch assembly. Here the manual method and automatic method are compared for each process. Investigation shows that few processes should be hold good during manual operation only. While few must be changed for automatic one. Table 6 shows the detailed analysis of each processes. The analysis indicates that the process "Cutting a piece of rod" need to be automated. So, by changing the current method of this process, assembly

cost can be reduced, which affects the overall cost of the product. A special purpose machine needs to be developed to fulfil this requirement. Such machine will be proposed in the later part. The machine may consists of motors, hydraulic actuators (Patel, *et al*, 2015), PLC and sensors.

Table 6 Summary of the Analysis

Process	Current Method	Recommended Method
Draw a raw material of brass rod	Manual	Manual
Cutting a piece of rod	Manual	Automatic
To make a slot on piece	Manual	Manual
To drill and thread in a hole	Automatic	Automatic

Acknowledgement

The author would like to thank Er. Bhavya Gajjar, Chhaya Industries, Plot no 3652, G.I.D.C phase 3, Dared, Jamnagar-361004 for their support and encouragement.

References

B.R. Gajjar, Saurin Sheth, (2014), Investigation of Automation strategy and its effect on assembly cost: A case study on Ball pen Assembly line, *International journal of current Engineering and Technology*, special Issue-3, pp. 89-92, ISSN 2277-4106.

P. A. Parikh, K. D. Joshi, S. Sheth, (2013), Color Guided vehicle-An Intelligent Material Handling Mechatronic system, *Proceedings of the 1st International and 16th National Conference on Machines and Mechanism (iNaCoMM2013),* IIT Roorkee, India, pp. 628-635. DOI:10.13140/RG.2.1.1348.4647

B.R. Gajjar, Saurin Sheth, (2014), Design and Automation in Back Plug Press Fitting Process of Ball pen Assembly, *Applied Mechanics and Materials,* Vols. 592-594(2014), pp. 2596-2600, DOI:10.4028/ www.scientific.net/AMM.592-594.2596

L. Masiyazi, K. Chiteka, D. Museka, (2014), Productivity improvement through Process optimization: case study of a plastic manufacturing and sales company, *Int'l conference Image processing, computer and industrial engineering (ICICIE'2014),* Kualalumpur, Malaysia.

T. Patel, V. Panchal, S. Sheth, P. Chauhan, (2015), Design and Development of Hydraulic Press with Die, *proceedings of 5th National Conference on Recent Advances in Manufacturing (RAM-2015)*, pp. 314-319, DOI: 10.13140/RG.2.1.2517.6169

S. Sheth, R. Kher, R. Shah, P. Dudhat, P. Jani, (2010), Automatic Sorting System using Machine Vision, *Multi-Disciplinary International Symposium on Control, Automation & Robotics*, at DDIT, Nadiad, India, DOI: 10.13140/2.1.1432.1448

M. Gupta, A. Patel, N. Dave, R. Goradia, S. Sheth, (2014), Text – Based Image Segmentation Methodology, *Procedia Technology,* 14(2014), pp. 465-472, DOI: 10.1016/j.protcy.2014.08.059

P. Chauhan, S. Rangrej, K. Samvatsar, S. Sheth, (2015), Application of Lean Manufacturing Principles for Process Time Reduction – A case of Conveyor Pulley Manufacturing, *proceedings of 5th National Conference on Recent Advances in Manufacturing (RAM-2015),* pp. 423-428, DOI: 10.13140/ RG.2.1.4412.5281

M. Virani, J. Vekariya, S. Sheth, K. Tamboli, (2013), Design and Development of Automatic Stirrup Bending Mechanism, *Proceedings of the 1st International and 16th National Conference on Machines and Mechanism (iNaCoMM2013),* IIT Roorkee, pp. 598-606, DOI: 10.13140/RG.2.1.2502.4725

T. Patel, S. Sheth, P. Patel, (2015), Design of Semi – automatic Hydraulic Blanking Machine using PLC, *Conference Proceedings of NCIET-2015*, SRPEC, pp. 410-412, DOI: 10.13140/RG.2.1.4529.6803

H. Gangadia, S. Sheth, P. Chauhan, (2014), Design & Modeling of Special purpose Equipment for Shell – Diaphragm Welding in Conveyor Pulley, *Procedia Technology*, 14(2014), pp. 497-504. DOI: 10.1016/j.protcy.2014.08.063

T. Patel, S. Sheth, B.S. Modi, P. Chauhan, (2015), Design of Semi – automatic Slotter Machine using PLC, *National Conference on Emerging Trends in Engineering, Technology & Management*, At INDUS Institute of Technology & Engineering, Ahmedabad, DOI: 10.13140/2.1.4842.5761

P. Chauhan, S. Sheth, (2014),Scope & Study of Just In Time – A case Study on Forging Industry, *proceedings of the 4th National Conference in Recent Advances in Manufacturing (RAM-2014),* pp. 300-305, DOI: 10.13140/RG.2.1.5156.0488

V. Chauhan, S. Sheth, B. R. Hindocha, R. Shah, P. Dudhat, P. Jani, (2011), Design and Development of a Machine vision System for part Colour Detection and Sorting, *Proceedings of 2nd International Conferences on Signals & Automation (ICSSA-11),* pp. 90-93, DOI: 10.13140/2.1.1628.7526

S. H. Desai, S. M. Sheth, (2012), Proposed Design of Centrifugal Casting Machine for Manufacturing of Turbine Bearing, *National Conference on Advances and Challenges in Engineering and Science (NCACES-2012),* DOI: 10.13140/RG.2.1.4529.2645

G. Boothroyd, P. Dewhurst, (1987), Product Design for Assembly. *Wakefield*.

M.P. Groover, (2001), Automation, Production Systems, and Computer-Integrated Manufacturing*, second ed. Prentice-Hall, Englewood Cliffs,* NJ, USA.

K. H. Barad, M. A. Bulsara, G. J. Patel, S. M. Sheth, (2009), Automation of Conventional Radial drilling machine, *National Conference on Innovations in Mechatronics Engineering (IME-09)*, GCET, V. V. Nagar, INDIA, pp. 32-36, DOI: 10.13140/RG.2.1.2301.1361/1

M. Vaghasiya, H. Moradia, R. Nayi, S. Sheth, B. Hindocha, (2014), Modeling of an Automatic Positioner – A Mechatronics Approach, *4th National Conference on Recent Advances in Manufacturing (RAM-2014)*, 26-28 June, 2014, pp. 284-289, DOI: 10.13140/RG.2.1.1550.2888

S. H. Desai, S. M. Sheth, (2015), Study and Proposed Design of Centrifugal Casting Machine for Manufacturing of Turbine Bearing, *Journal of Material Science and Mechanical Engineering (JMSME)*, DOI: 10.13140/RG.2.1.2503.0566