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I. J. Isaac Premkumar, Sanjeevi Basker, R. Saravanan, V. Vijayan, A. Parthiban, and T. Sathish

Dwindling Setup Time through a Low-Cost Mechanization – A Case Study

I.J. Isaac Premkumar[1, a)], Sanjeevi Basker[2, b)], R. Saravanan [3, c)], V. Vijayan[4, d)] A. Parthiban[5, e)], and T. Sathish[6, f)]

[1]Department of Mechanical Engineering, JCT College of Engineering and Tech., Coimbatore, Tamilnadu, India.
[2]Department of Automobile Engineering, VELS Institute of Sci., Tech. & Advanced studies, Chennai, Tamilnadu, India.
[3]Department of Mechanical Engineering, Ellenki College of Engineering and Tech., Hyderabad, Telangana state, India.
[4]Department of Mechanical Engineering, K. Ramakrishnan College of Technology, Trichy, Tamilnadu, India.
[5]Department of Mechanical Engineering, VELS Institute of Sci., Tech. & Advanced studies, Chennai, TN, India.
[6]Department of Mechanical Engineering, Saveetha School of Engineering, SIMATS., Chennai, Tamilnadu, India.

[a)]Corresponding author: isaacpremkumar007@gmail.com
[b)]baskar133.se@velsuniv.ac.in
[c)]dr.sarravanan@gmail.com
[d)]vijayan.me@gmail.com
[e)]parthibana@yahoo.co.in
[f)]sathish.sailer@gmail.com

Abstract. Nowadays World class manufacturing organizations continuously try to provide highest quality products at the lowest price by implementing innovative approaches for optimizing their production system. Mechatronics play an important role in meeting such requirements, because “Quality is Free”. With this aim the processes are studied for optimizing work method and time. The optimization of work method can be done by reducing work content by improving the processing methods and the time can be optimized by automating the process. This systematic approach of process improvement is illustrated with a case study. The case study has been carried out in a leading car manufacturing industry (Ford India Limited) The process is improved by designing a mechanism and was mechanized by applying Mechatronics concepts for obtaining higher accuracy and quick processing. Here two kinds of solution were suggested and compared as well. The both new setups eliminate the drawbacks in the existing method (Manual Processing). Actually, Manual processes will lengthy, tedious, time consuming and consequently error prone. The proposed machine setups designed completely and demonstrated successfully.

INTRODUCTION

The Recent trend is: human denies tolerating the human error in the products and services. Human raises the issues related to safety and security in the working environment. The automation or mechanization are some cases provide the opportunity to fulfill such requirements. That is quality in products and services. The most powerful techniques were suggested in the literature to face such issues. [1] applied Six Sigma method of ECRS methodology improved production rate and casts of the expansion plan and met the demand of 72000 units per annum from the usual production of 57600 units per annum. [2] enhanced the processing rate of processing gear box quality check up from 2496 gear boxes per annum to 3624 gear boxes per annum by mechanization of loading and unloading tasks. [3] improved the production by line balancing methodology as well as priority based processing on the bottle neck machines and thereby increases the turnover tremendously [4] improved TIG welding plant production by introducing material handling equipment for processing there by the production rated increased from 13680 to

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18720 units per annum. [5] increased the profit of 10% through mechanization. This paper addresses setup time reduction through mechanization in a leading car manufacturing firm.

PROBLEM

This case study was carried out in a leading car manufacturing plant. The press bay consists of six presses are in-line, to manufacture the body parts of mainly two+ car models. The first press is a double action typepress of a capacity of 1800 ton and the rest of five presses are single action type with the capacity of 1000 tons. There are 18 common dies to manufacture the parts of two car models, namely Ford Fiesta and Ford Ikon. the process setup diagrammatically illustrated in Figure 1. First the blanks are blanked into definite dimensions at the blanking area and are transported to the de-stacker. The technician manually sets the reference on the roller bridge, according to the part that is to be manufactured. Now the blanks are manually fed onto the roller bridge and the blank slide over the rollers and reach the centering table after passing through the blank washer. Here a pneumatic arrangement locks the blanks firmly on to the centering table (that is the horizontal movement of the blanks are arrested). A loader attached to Press1 picks the blanks from the centering table and places it on the die inside Press1. The upper die clamped on to Press1 is released and it reciprocates to stamp the blanks into desired shape and size. Once the upper die reaches the top dead center the un- loader picks up the part and places it on the conveyor belt. The conveyor belt transports the part and the part is manually loaded onto the next press. Depending upon the part that is produced the number of presses to be used isvaries. Hence the reference to the roller bridge is set manually each time when there is a die change. This leads to loss of time and fatigue to the technician performing the task

FIGURE 1. The Press Bayof the car manufacturing Industry

MATERIALS AND METHODS

Problem Analysis

This research focuses the problem on the Press 1. The existing facilities in front of the first press machine areillustrated in Figure 2 in by a three dimensional outline diagram. The brief description about the setup is furnished below.

Blank feed

It is the process of feeding the blanks into the press line [6-21]. The blank is manually fed over the roller bridge which transports the blank into the washer and then the centering table [22-36].

Roller Bridge

: The roller bridge is an arrangement by which the blanks are transported from the de-stacker through the blank washer to the centering table. The path travelled by the blank must be uniform and linear till it reaches the centering table [37-49]. To achieve this there is a reference to the roller bridge which needs to be adjusted manually on every die change.

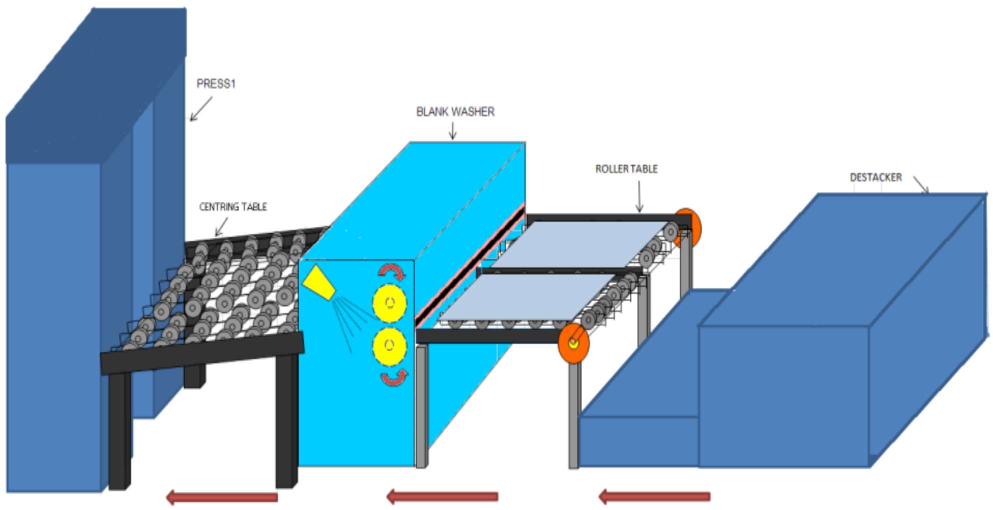

FIGURE 2. Facilities in front of the first press machine

Blank washer

The blank washer is used to remove the dirt and foreign particles from the blank. Oil is sprayed over the blanks for better draw ability and rust prevention [50-63].

Centering Table

The blanks travel from the blank washer to the centering table. The crowdars placed on the centering table and position the blanks with respect to the die in the first press [64-70].

Proposed Solutions

There are two kind of proposals is proposed and evaluated to avoid the manual setup. They are Solo drive system and Identical twin drive system.

Solo Drive System

Manual setup may be supported by mechanized system which will cutting down the time consumption, improve accuracy and greatly reduce operators fatigue. So the authors design a system named as single motor system.The design requirements are: Torque required for each lead screw is 20Nm; Total torque required is 40Nm; Required speed of each lead screw(N2) is 140 rpm; Capacity of the motor will be 1HP; Speed of the motor(N1) should be 1400Rpm; Gear ratio must be (N1 /N2)= 10:1 ; and the components Requirements are one motor with gear box and shafts, lead screws,electric switches and electromagnetic clutches are two in each

Working Principle

The motor is mounted at the center of the roller table and is attached to the 2 lead screws with an electromagnetic (or the purpose of disengaging the lead screw) clutch. The motor is started with a push button. To operate the lead screw separately, the electromagnetic clutch is used to engage and disengage the shafts. The control is obtained through a limit switch arrangement.

Electric Circuit

Thecurrent passes through the normally closed stop button and reaches limit switch when forward push button is activated the motor rotates in the forward direction and the circuit breaks when it encounters the pin. Now the electromagnetic clutch is activated and the shaft is released. Similarly, the same procedure takes place on the other side. A safety switch is also placed (F end and R end) in case of any over run.

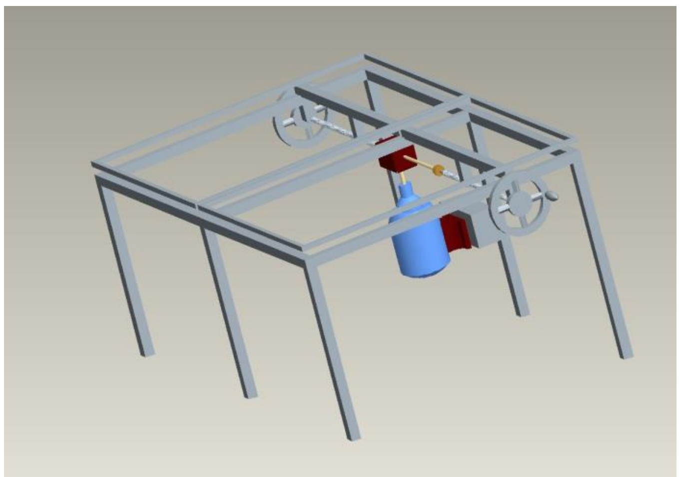

FIGURE 3. Working Principle Solo Drive System

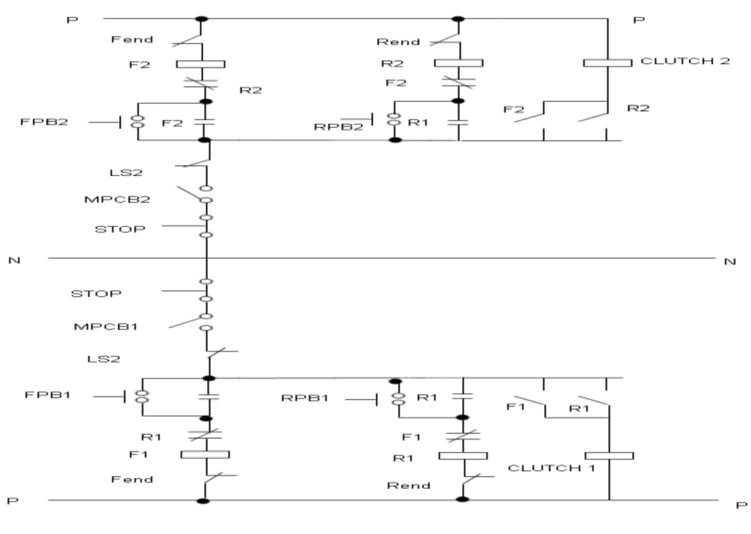

FIGURE 4. Electric circuit for Solo Drive System

Feed Back

Time is saved in roller bridge setting, accuracy improved in setting and fatigue reduced greatly for the operator. But adjusting the reference separately was a complex task which Requires manual involvement and installation of an electromagnetic clutch is costlier. So the authors redesign the system which is named as twin motor system.

Identical Twin Drive System

The system is designed for overcome the difficulty faced in single motor system. The follwing design reqiurements were derived such as Torque required for each lead screw is 20Nm, required speed of each lead screw(N2) is 140 rpm, capacity of the motor is 5HP, speed of the motor(N1)=1400 rpm andGear ratio(N1 /N2)= 10:1 and the components requirements were Motors, as well as Gear boxes, shafts, lead screws and electric switches are 2 numbers in each.

Working Principle

Two motors along with its gear boxes are mounted on either side of the roller bridge. Motors is operated using push buttons. The control is achieved using limit switch arrangement. Once the push button is pressed the reference is set along scale and it stops at posit ion where the limit pin is set.

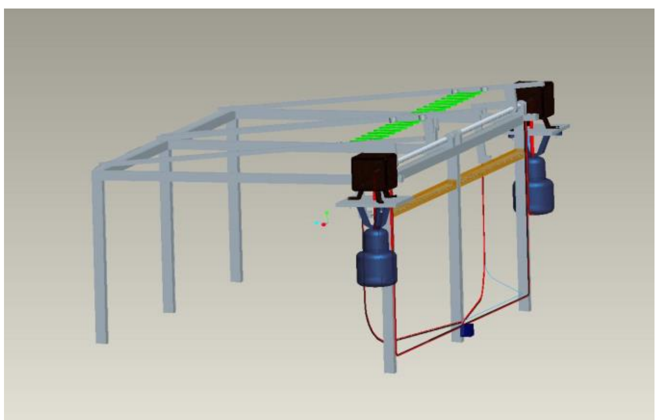

FIGURE 5. Electric circuit for Solo Drive System

Some notations used in electrical circuits are:

1	Lead screw1
2	Lead screw 2
P	Phase
N	Neutral
F END	Forward end
R END	Reverse end
F	Lead screw forward
R	Lead screw reverse
FPB	Motor forward push button
RPB	Motor reverse push button
LS	Limit switch in solo drive system
MPCB	Miniature power circuit breaker
LS2	Reference limit switch
LS1	Safety reverse end limit switch
LS3	Safety forward end limit switch

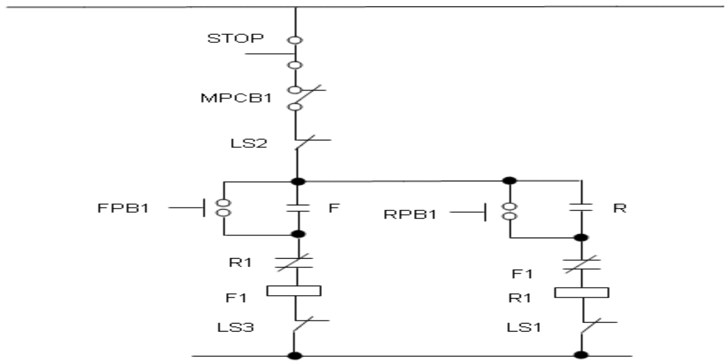

FIGURE 6. Electric circuit for Solo Drive System

RESULTS AND DISCUSSIONS

Comparison

The both of the proposed systems' features are comparatively presented here below for justifying best proposal. The design and features aspects are comparatively presented in the Table 1. Details of Cost involved in Solo Drive System and Identical Twin Drive System are furnished in Table 2 and Table 3 respectively.

TABLE 1. Comparative features of Proposed drive systems

S. No	Description	Solo Drive System	Identical Twin Drive System
1	Structure	Compact	Complex
2	Manual Involvement	More	Less
3	Time Consumption	More	Less
4	Installation	Easy	Complex
5	Maintenance	More	Less

TABLE 2. Cost Details of Solo Drive System

Material	Quantity	Unit cost	Cost in Rupees
Motor	1	Rs.5700	5700
Gear Box	1	Rs.7000	7000
Limit Switch	2	Rs.1500	3000
Plate(10 mm thick;1'X1'Sq.ft)	1	Rs. 300	300
Electromagnetic Clutch	2	Rs.5000	10000
Installation Charges			5000
	Total cost of the equipment		31000

TABLE 3. Cost Details of Identical Twin Drive System

Material	Qty	Unit cost	Cost (Rupees)
Motor	2	Rs.4200	8400
Gear Box	2	Rs.7000	14000
Limit Switch	2	Rs.1500	3000
Plate(10 mm thick;1'X1'Sq.ft)	2	Rs. 300	600
Installation Charges			5000
	Total cost of the equipment		31000

CONCLUSION

Hence the Twin motor system designed with improved performances without changing the cost of the system.The implementation of Twin motor system improves the working condition such as assured quick accurate settings while changeoverand greatly reduced operator's fatigue that is the technician is relieved from setting the roller bridge completely and he can perform other tasks which will improve the efficiency of the process. Thus, for a better working environment and improved efficiency this system is highly recommended. The system performance can improve by using Programmable Logic circuit (PLC) can be used to improve the system's performance in terms of safety and accuracy. Encoders can also be used to improve the accuracy and safety of the system. Pneumatic motors can cut down the power consumption and can thus save a lot of energy.

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