International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 03 | June-2015 ww.irjet.net p-ISSN: 2395-0072

Reduction of work in process and finding critical machines and bottle necks using simulation and Design of Experiments

Mr.Sundar.J[1], Mr. Vivekanand Venkataraman[2]

[1] *Sundar J, M.Tech student, IEM Department, MSRIT, Bangaluru,Karnataka,India*

[2] *Vivekanand Venkataraman, Assistant professor, IEM Department, MSRIT,Bangaluru,Karnataka,India*

---***---

Abstract - *This* project work is carried out at axle factory, it is a production plant, which mainly manufactures various sizes of wheels and axles, through the forging process in axle shop and casting in wheel shop. Apart from that the company manufactures various types of axles, currently this company is facing lot of work in process at various areas in the shop floor. In order to reduce work in process. There is need to understand the system behavior and factors which affect the system behavior. Work in process due to various factors such as variability due to process time, setup time, time between failures, down time and travel time, to understand how this set of factors play a role in affecting the work in process it would be essential to conduct simulation and design of experiment. In this study simulation model was created for various bottle neck areas and system was analyzed by changing the various factors by using design of experiments approach. The necessary improvement was suggested based on the simulation, ANOVA results, main effect plot and interaction plot.

Key Words: DOE, Simulation, Work in process, Etc.

1. Introduction

Axles:

The manufacturing industry procures high-quality vacuum-degassed steel blooms from large-scale steelmakers. Axles are manufactured from billets cut from the blooms. These blooms are forged in a precision long-forging machine. The billets are heated in a rotary hearth furnace to forging temperatures. Billets are then forged in axles on a special purpose long forging machine. The forged axles are gas cut to required length. The axles are heat treated through various heat treatment processes. The physical properties are confirmed before machining of the axles. The forged axles are machined on various machines. The operation consists of end machining, rough turning; finish turning, spm machining, grinding and burnishing. Internationally standardized tests (ultrasonic, magnetic particle, etc.) are used to confirm the quality of the axles.

Figure 1: axles

2. Project problem definition

The main purpose of this project is to reduce the work in process of manufacturing system, so the project's objective is to understand the behavior of manufacturing system and hence identifying the factors which play a vital role in affecting the System behavior .In addition to that due to change in demand variety there is also a need to understand the performance of the system under there kind of scenarios. Works in process are partially finished goods waiting for completion and eventual sale or the value of these items. These items are either just being fabricated or waiting for further processing in a queue or in a buffer storage. These set of objectives can be accomplished by the use of simulation and the results obtained would be able to understand performance under various scenarios. Hence project problem can be defined as "Reduction of work in process and finding the critical machines and bottle neck using simulation modeling and design of experiments".

3. Methodology

To achieve the objective of the project, a nine step methodology will be followed. The flow chart gives a pictorial representation of the methodology

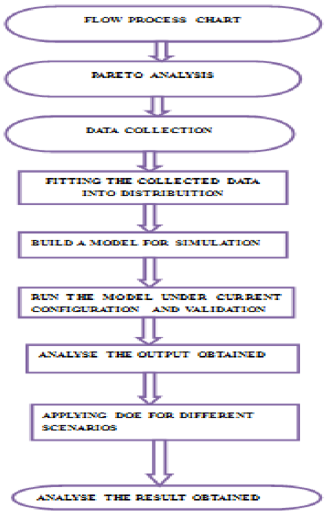

Figure 3.1: Methodology chart

Pareto analysis

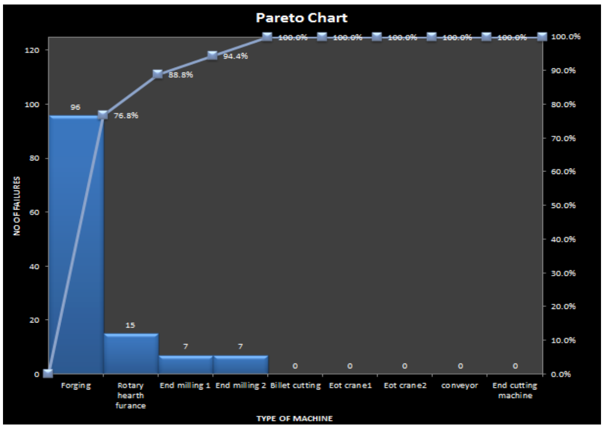

Figure3.2: Pareto diagram for number of failures of different machines

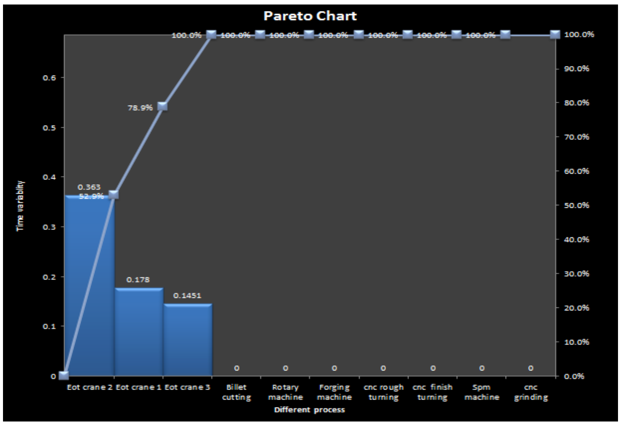

Figure3.3: Pareto analysis for time variability

By the help of Pareto diagram the critical lines are identified and solved out by using simulation and design of experiments.

4. Results

RESULT FROM ARENA SOFTWARE

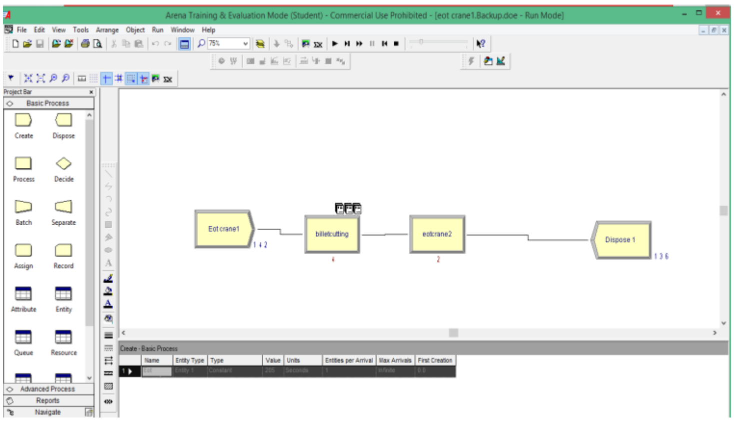

Figure 4.1: Model 1 results from arena software.

MODEL 1

1. The model 1 shows how the material flows from blooms yard to conveyor of Rotary hearth furnace machine
2. Here from the model we can see that the actual output after billet cutting near conveyor RHF machine is 136parts for a shift but RHF furnace can process only 90 parts in a shift the reaming billets have wait for their turn hence this causes work in process
3. After billet cutting machine if a conveyor connects to the conveyor of RHF then result says one billet cutting can supply to two RHF furnace and two forging machine
4. EOT crane can be used for other purpose

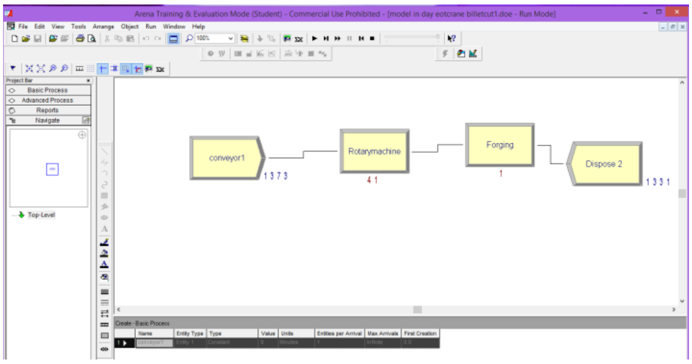

Figure 4.2: Model2 results from arena software

MODEL 2

1. The model 2 shows how the material flows from conveyor of RHF machine to forging machine
2. Here from the model we can see that there are lot work in process due forging failure maintenance and RHF maintenance.

3. From model we can understand that 4.1 minutes time for avoids work in process between RHF, forging in axle forge shop
4. If we avoid maintenance and if maintenance reduces 0 we can produce extra 190axles in a month.

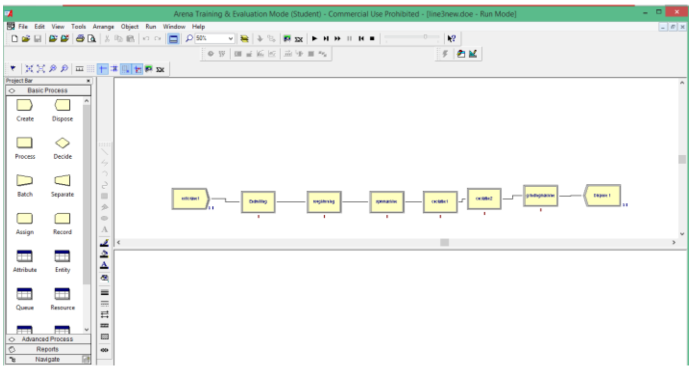

Figure 4.3: Model 3 results from arena software.

MODEL3(line2)

1.Model 3shows axle moved from end milling ,rough turning,spm machine,grinding machine.
2.How ever this line are producing 45 axles per shift if the line is properly balanced then line could produce 50 axles
3.The major work in process is due to end milling were it could produce 70 Axles in ashift
4.In line 3 there is a need of conveyor after grinding machine because after cnc grinding the parts are kept on the ground there is lot work in process here the parts are moved by EOT cranes and fork lift which consume lot of time

MODEL4(line3)

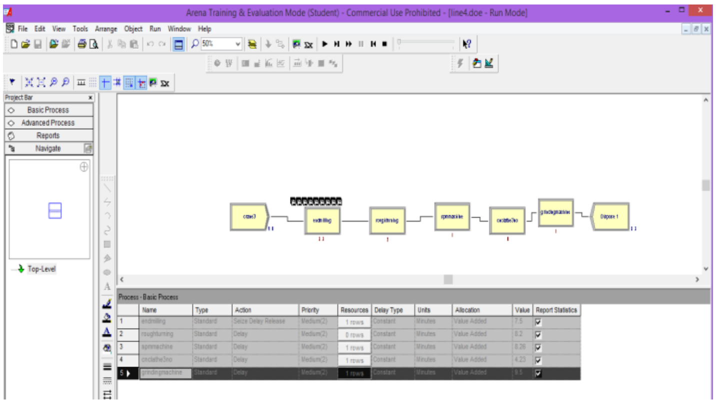

Figure 4.4: Model 4 results from arena software.

1.Model 4 shows axle moved from end milling ,rough turning,spm machine ,grinding machine.
2.How ever this line is producing 45 axles in the line if line is properly balanced then line could produce 50 axles
3.The major work in process is due to end milling were it produces 70 Axles in ashift

Analysis of Variance

Table 4.1: 2^3 design of Anova table for finding out major cause for work in process.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	7	302186	43169	606.13	0.000
Linear	3	282174	94058	1320.64	0.000
Batch size	1	261822	261822	3676.17	0.000
Iat between batches	1	1854	1854	26.03	0.000
Iat between forging	1	18498	18498	259.72	0.000
2-Way Interactions	3	19786	6595	92.60	0.000
Batch size*Iat between batches	1	2202	2202	30.92	0.000
Batch size*Iat between forging	1	17459	17459	245.14	0.000
Iat between batches*Iat between forging	1	125	125	1.75	0.187
3-Way Interactions	1	226	226	3.18	0.076
Batch size*Iat between batches*Iat between forging	1	226	226	3.18	0.076
Error		232	16523	71	
Total		239	318709		

From the table 4.1 seeing the p value we can conclude all are significant.

Main Effects Plot

The Main Effects Plot plots means of factor levels and it is used to visualize the magnitudes of main effects. The following figures show you how to interpret different types of Main Effects Plot.

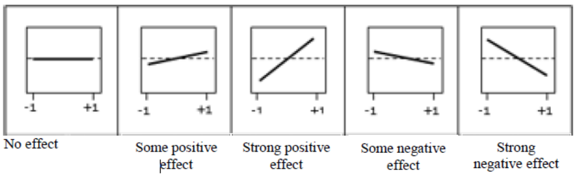

Figure 4.6: Main effect plot

From the main effect plot we can concolude that batch size of 3 cause the major wip near billet cutting

Interaction Effects plots

The Interactions Plot plots the means for each level of one factor with the levels of another factor. For more than two factors, a matrix of interaction plot is generated. It is used for identifying interactions between factors.

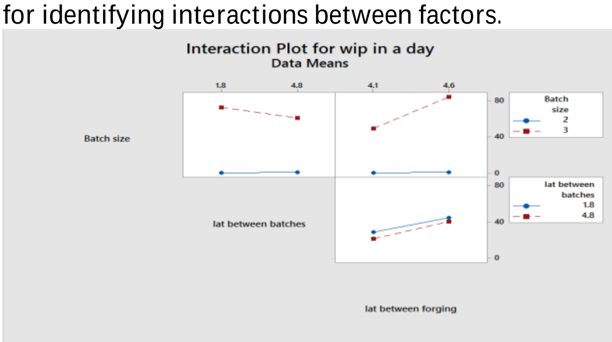

Figure 4.7: interaction plot for WIP in a day.

5. CONCLUSION

By the usage of simulation and design of experiment approach it was found that the work in process near billet has been significantly reduced .the major factor that affect work in process include batch in size, interarrival between the batches and inter arrival time between forging out of these three factor the batch size has huge reduction for work in process ,especially batch 2 reduced the work in process to 2 .this shows batch size can be used to reduce the work in process ,it is also seen from the maintenance down time and time between failure are significant in reducing work in process. Reducing the down time as minimum as possible and increasing the up time would fetch a huge improvement in throughput and reduction in work in process.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to Mr.Vivekanand Venkataraman for providing the guidance throughout the completion of the project work.

REFERENCES

[1] Modeling the Fruit Processing Line and Understanding its Behavior through Simulation, Designed Experimental Approach author Kiran Hanjar. S Vivekanand Venkataraman2, M. R. Shivakumar volume3 issue6, June 2014

[2]. Sokolowski, J.A., Banks, C.M. (2009). *Principles of Modeling and Simulation*. Hoboken, NJ: Wiley. p. 6. ISBN 978-0-470-28943-3

[3]. SIMEONOV S., SIMEONOVOVÁ J. (2002): Simulation scheduling in food industry application. Czech J. Food Sci., 20: 31–37

[4]. J. Banks, J. Carson, B. Nelson, D. Nicol (2001). Discrete-Even6+8t System Simulation. Prentice Hall. p. 3. ISBN 0-13-088702-1

[5]. Rodrigo Ferro, Maria Célia de Oliveira Papa, André LuisHelleno, Aroldo José Isaias de Moraes “Application of simulation for sizing of work in process (WIP)”.

[6]. Kamath, M. (1999). Recent development in modeling and performance analysis tools for manufacturing systems

[7]. Liqi Ang, Kuan Yew Wong and Wai Peng Wong “Simulation of Sequencing Rules Using Witness in a Milling Job Shop” *Vol. 2011 (2011),*

[8]. Benedettini, O., Tjahjono, B. (2008). "Towards an improved tool to facilitate simulation modeling of complex manufacturing systems".International Journal of Advanced Manufacturing Technology 43 (1/2).

[9]. Run Zhao Soemon Takakuwa 2012 “Simulation-Based Distributed Fuzzy Control For Wip In

