International Journal on Applications in Engineering and Technology
Volume 4 : Issue 1: March 2018, pp 24 –26 www.aetsjournal.com ISSN (Online) : 2455 - 0523

Productivity Imrpovement in Foundries using Lean Tools

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Abstract— To study and implement the lean tools and to reduce lead time without much affecting the current working systems in a small scale automotive component manufacturing industry. An attempt was made in increasing the capacity of a machining cell with appropriate lean techniques. The enhancement of capacity was to be completed with zero capital investment. A lean approach by using value stream mapping and line balancing was adopted to improve the performance of the manufacturing cell. By collecting the past production data and deciphering the information, gaps were identified for enhancement. Single Minute Exchange of Dies (SMED) was used to regulate the production and Kaizen was also introduced in all work stations. Levelled operator loading for output consistency was suggested. Finally, capacity intensification was achieved without any major capital investment. Implementation of lean tools reduced the setup time and idle time. The overall lead time got reduced from 6.9 days to 3.6 days and the total cycle time got reduced from 170 to 140 minutes and the customer demand was also met on time by the execution of lean tools.

Keywords— Fault Tree Analysis, Linear Least Square Regression, Shrinkage, Rejections

I. INTRODUCTION

Every manufacturing process is subjected to variations that limit our ability to produce a defect-free product. The variation enters into the product from the very beginning of its life cycle. In this case, the process being metal casting, the variations arise in the form of casting defects. It is important to the producer, designer and engineer that the defects occurring in castings are recognized and their origin and control be properly understood.

The demand for quality has focused attention on the effects of casting defects on the cost and performance of manufactured products. It is known that every rejection of the product adds to the profit loss to the firm. Hence, it becomes absurd to regret it after the defect is allowed to happen. The possible solution is to predict the amount and the area at which the casting defect is about to occur and to figure out the root cause of the defect.

Defects in castings often appear unexpectedly and it is difficult to identify their source as they can be brought about by a large number of randomly changing production parameters. These defects lead to more reworking time, increased production cost and more consumption of energy resulting in fewer sales volume and profit margin. This paper is all about productivity improvement in foundry firms by using lean tools.

This paper deals with the prediction of the amount of casting that would be rejected shortly through the expert system using linear least square regression amalgamated with C-language. It also listed a possible solution for such rejections by applying a lean tool such as Fault Tree Analysis (FTA). Using the history of the rejected product prediction of the amount of rejection and its cause is done by the expert system. Then by applying FTA, the root cause of the defect is founded out that improved the rejection percentage from 7.3% to 5%. The expert system and the solution when implemented in any foundry would reduce casting defects and improves the overall functioning, production rate and profit margin of the firm.

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II. DATA COLLECTION

Data collection forms the important phase in this systematic approach because it is based on these data that the expert system predicts the amount and the predominant defect. The data involves the amount of casting that was rejected due to a particular defect in a definite time interval. A sample of the collected data is shown in Table.1.

Table 1 A sample of the collected data

Month	April	May	June	July	Aug	Sep
No. of goods	3113	2628	2573	2189	3347	2774
No. of rejections	268	197	507	435	419	248
Sand Inclusion	175	51	376	314	280	234
Shrinkage	23	41	75	32	61	52
Misrun	16	43	24	61	76	43

III. FAULT TREE ANALYSIS

Fault Tree Analysis (FTA) is a graphic depiction or model of the rationally conceivable sequences of events within a complex system that could lead ultimately to the observed failure or potential failure. In our case, the potential failure is the defect that caused the casting to be got rejected. Since we have found out the most predominant defect of all, it gives a confined area to be focused on. With the help of Fault Tree Analysis (FTA), we can derive the root cause of the defect. To have a clear understanding of the FTA one has to know the symbols used in FTA. The symbols used in fault tree analysis are presented in Table.2 and a sample fault tree developed for the defect shift is presented in Fig. 1.

Table 2: Symbols used in FTA

Logic gates	OR-gate	The OR-gate indicates that the output event occurs if any of the input events occur
	AND-gate	The AND-gate indicates that the output event occurs only if all the input events occur at the same time
Input events (states)		The basic event represents a basic equipment failure that requires no further development of failure causes
		The undeveloped event represents an event that is not examined further because information is unavailable or because its consequences are insignificant
Description of state		The comment rectangle is for supplementary information
Transfer symbols	Transfer out Transfer in	The transfer-out symbol indicates that the fault tree is developed further at the occurrence of the corresponding transfer-in symbol

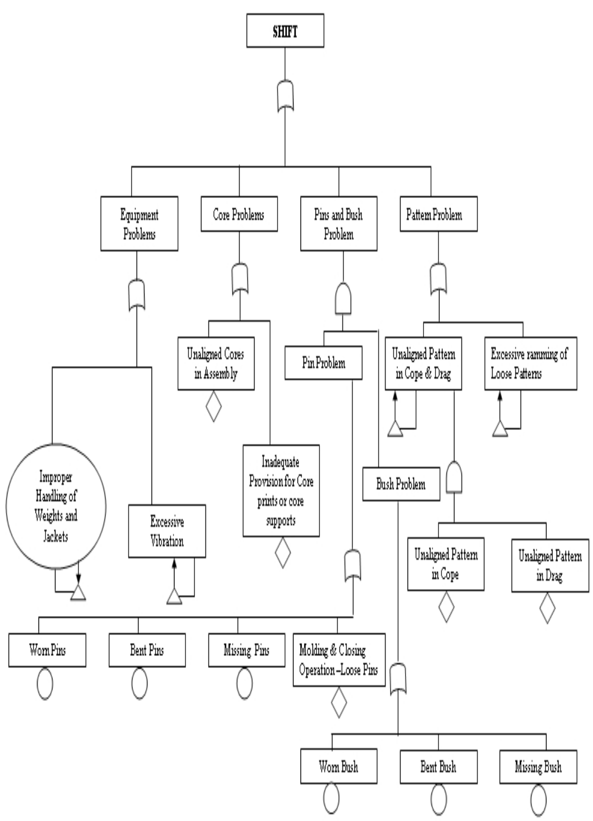

Fig.1 Fault Tree Diagram for Shift

IV. DEVELOPMENT OF THE EXPERT SYSTEM

The quantity of the product that would be rejected shortly can be predicted using the expert system. This expert system not only calculates the quantity but also provides the type of defect that is about to happen. The prediction work is performed using a *Linear Least Square Regression* (LLSR). This LLSR has been converted to an Expert System by using the *C-programming language*. This involves a number of steps to arrive at the final result.

To make use of the expert system we require the history of the rejected product for different defect categories which is collected previously. These data are fed into the Expert System and the final output of the system is of the form

$$Y=f(X, \beta) + € \qquad \text{[Eq.No.1]}$$

Where $f(X, \beta) = \beta_0 + \beta_1 x$

X – No of defects

β - Parameter constant

€ - Error compensation

The parameter constant can be obtained by minimizing

$$Q = \sum_{i=1}^{n} [y_i - (\beta_0 + \beta_1 x_i)]^2$$

Then taking partial derivatives of Q concerning β_0 and β_1 and setting each partial derivative equal to zero, and solving the resulting system of two equations with two unknowns yields the parameter constant as

$$\beta_1 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

$$\beta_0 = \bar{y} - \beta_1 \bar{x}$$

Thus the parameter constant values are founded out. Substituting these values in equation no.1 results in the final equation. In the case of the collected sample, we obtained the following equation.

Y= -0.57x + 2895.70 (Sand inclusion)

Y= -7.84x + 3177.44 (Shrinkage)

Y= 9.04x + 2417.34 (Misrun)

In these equations, the unknown ‘X is the number of defects. By feeding the number of castings that will be produced in the next time interval the expert system predicts the predominant defect ant its quantity. The data input to the expert system and the equations generated by the expert system are shown in Fig.2 and the output in the form of the predominant defect and its quantity s shown in Fig.3.

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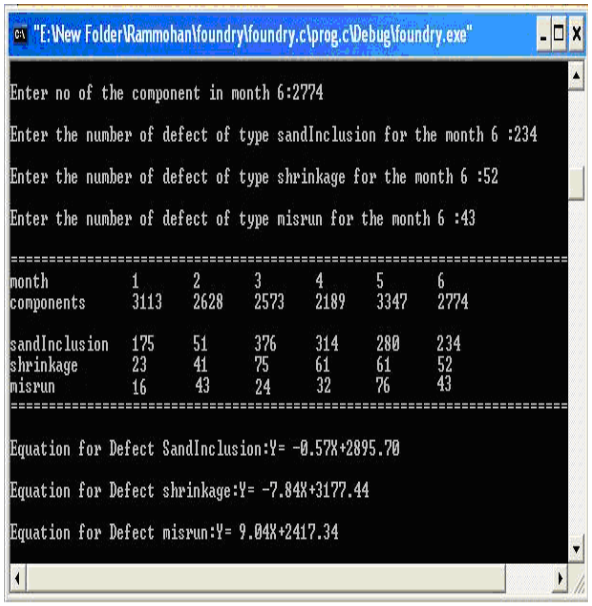

Fig.2: Data Input and the equation generated

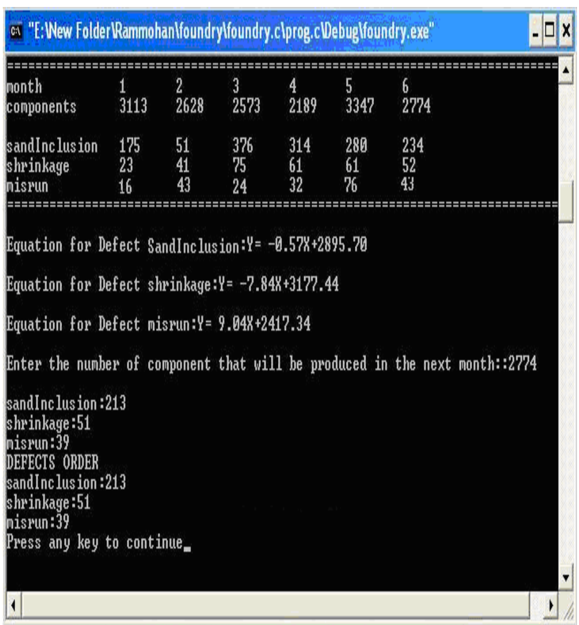

Fig.3 Data Output in expert system

V.RESULTS & DISCUSSION

From the result of the expert system, it is founded that the quantity of defect (Sand inclusion) for the future month is 213, but the resulted failures were found to be 132. This reduction in the rejection percentage is accomplished by the use of this Expert system and FTA.

Thus by using the expert system and FTA it is possible to control the defects, thereby increasing the profit margin and productivity of the firm. In this case, the rejection percentage has improved from 7.3% to 5%. This systematic approach is not limited to this foundry alone; it can be applied to all foundries.

VI. CONCLUSION

Thus the expert system helps to predict the values of the quantity of the defects that will occur in the future and can be prevented before the defect happens by the tool - Fault Tree Analysis. Fault tree analysis is highly effective in determining how combinations of events and failures can cause specific system failures. This paper deals that the possibility to change the future of the firm by the premonition of the defects using the expert system. Although, the process that is performed in the firm must be consistent with no sudden variation. If so the result provided by the system will contain some errors. By implementing this system the firm can identify certain minute mistakes that are explored by the usage of Fault tree analysis. Thus the project serves to a great extent irrespective of the firm.

REFERENCES

[1] Howard F. Taylor, Merton C Flemings & John Wulff, "Foundry Engineering", John Wiley and Sons Ltd. 2003.
[2] Richard W Heine, Carl R Loper, Philip C Rosenthal "Principles of Metal Casting", Tata McGraw – Hill Publishing Company Ltd, 2004.
[3] Marwin Rausand, Fault Tree Analysis, Wiley 2004.
[4] Byron s Gottfried, "Programming with C", Tata McGraw – Hill Publishing Company Ltd., 2002
[5] Robert Lafore, "Turbo-C", Galgotia Publications Pvt Ltd., 2000.