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RESEARCH ARTICLE

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A CNC MACHINE FAILURE FORECASTING AND RELIABILITY ANALYSIS USING DATA FROM A CMMS (COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM) SOFTWARE

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ABSTRACT

The Machine performance of a manufacturing plant directly affects the profitability of an organization. Managing optimum machine performance has become very challenging due to emergence of advanced technology and complex processes. The need for precise machine performance information on time has become a crucial input parameter. Hence, CMMS is mostly used in good manufacturing organizations as a reliable tool for recording breakdown events. Untimely machine breakdowns increase the downtime as well as reduce the machine life, in both cases profitability of an organization gets severely affected. Understanding and estimating the machine failures before time by using Reliability Engineering method is a very powerful technique now being used in leading companies in the world. A proactive action to maintain the machine before the breakdown occurs can bring in substantial increase in OEE and profitability of the organization. A failure forecasting analysis of a CNC machine is being demonstrated using Reliability Engineering method on a data recorded in a CMMS software (FTM*)

1. INTRODUCTION

In last 20 years competition in manufacturing sector has been accelerating across the world. Easy access to technology, instant global connectivity, faster product obsolescence and constantly increasing input costs etc are some of the crucial factors intensifying the competitive business environment. The conventional methods of cost control are no more secrets hence, adopted by everyone in the manufacturing world and that is not a competitive advantage anymore. Manufacturing world is focusing to identify new areas of cost reduction to stay competitive, plant maintenance is one of such area which can contribute a lot to increase the productivity reducing downtime and increase the profitability[1,2]. The future forecasting information can always help the Plant engineers to rectify the defects before it turns into a breakdown, resulting additional profits simultaneously reducing the cost[7,8,9].

2. Experimental Design

A two years real-time breakdown data of a CNC crankcase grinder has been observed and analyzed to study the machine behavior. The available breakdown data trend has been analyzed using statistical techniques. A proactive maintenance activity reduced the number of breakdowns and saved substantial production losses [3,4,10].

2.1 Input

I. The failure details and Maintenance of machine log data is received for Reliability analysis
II. Data range is the collection from 1st Jan 2010 to 31st Dec 2012
III. Data looks good and it's a disciplined effort.
IV. Description of Problem is available for all logs, so treated as Failure Mode
V. Cause details are not available for all logs

2.2 Output

I. Failure Analysis
II. High Level Machine (System) metrics
III. Top Failure Modes Modeling
IV. Modeling and Forecasting
V. Control Charts

3. Failure Analysis - Repetitions - 543 records were logged out of which 6 were repetitions of the previous one. Difference only in the cause description, so deleted them. Total considered records are 537.

Top Failure Modes:

Table 1: Failure modes

Problem	Count of Failures	Percetnage of Failures
Positioner problem	67	12.48%
Clamping problem	44	8.19%
Steady problem	39	7.26%
Spark Spitter problem	33	6.15%
Crank Head problem	24	4.47%
Coolant problem	21	3.91%
Hydraulic	15	2.79%
indexing problem	11	2.05%
latch signal problem	9	1.68%
latch signal absent	7	1.30%
Others	267	49.72%
Total	**537**	

Table 2: Days of failures

Day of Failure	Count of Failures
Saturday	98
Monday	96
Tuesday	84
Thursday	83
Friday	80
Wednesday	76
Sunday	20

Description of Problem should be standardized with only one entry per type of problem. Same problems cannot be entered in two different wording. Example here is Latch Signal problem and Latch Signal absent [9,10].

4. Assessment of Downtime

Table 3: Downtime analysis

Percetnage of Failures	Downtime
25%	26 mins
33%	30 mins
50%	38 mins
67%	57 mins
75%	1hr 11mins
90%	2hr 16mins
96%	4 hrs

Year	Failures	Down time(Hrs)
2010	187	229
2011	178	221
2012	172	241
Total	**537**	**691**

Recovery Days	Failures
Same Day	525
1 Day later	11
2 Days Later	1
Total	537

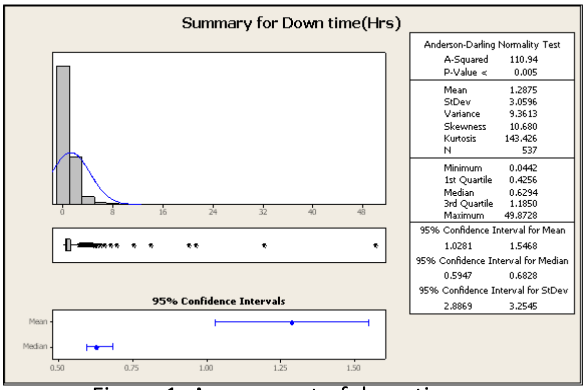

Figure 1: Assessment of downtime

Good Recovery time (less downtime). However there are quite a few higher time taking failure modes. These need special attention.

4.1 Failures and Downtime by Year & Month

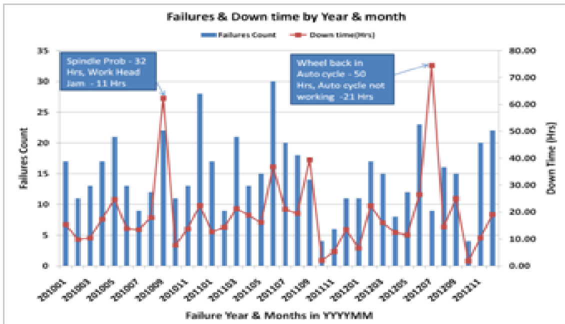

Figure 2: Year-wise downtime analysis

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4.2 System Level Metrics

a. Total No: of Failures- 537 Failures
b. Total Down time - 691.36 Hours
c. MTBF (Mean Time between Failures) - 43 Hours or 1.79 Days
d. MTTR (Mean Time to Repair) - 1.29 Hours
e. Failure Rate Per Hour - 0.0226 Failures per work hours
f. Availability- 97.09%
g. Assumptions for the metrics are enclosed in Assumptions slide

4.3 Subsystem specific failure forecasting

a. Top Failure Modes are Modeled i.e. Positioner problem, Clamping problem, Spark Spitter problem, Crank Head problem, Coolant problem

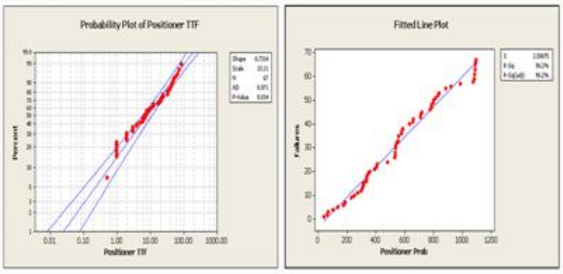

Figure 3: Positioned plot and fitted line plot

b. Depending upon the data either the Reliability Modeling approaches or the Statistical modeling approaches are used for the forecasting.

Better the data entry better would be the modeling and forecasting. So Problem description and Cause Nomenclature is very important.

5. Results & Analysis

Table 4: Failure Forecasting

Year &Month	Total days	Work Hours (Est)	Forecasted Failures	Downtime (Hrs)	Failures from Specific Problem				
					Positioner	Clamping	Spark Spitter	Crank Head	Coolant
January-13	31	632	15	18.37	2.03	1.23	1.79	0.48	0.53
February-13	28	608	14	17.67	1.78	1.11	1.62	0.43	0.48
March-13	31	640	15	18.60	1.97	1.23	1.79	0.48	0.53
April-13	30	632	15	18.37	1.90	1.19	1.73	0.46	0.52
May-13	31	656	15	19.06	1.97	1.23	1.79	0.48	0.53
June-13	30	640	15	18.60	1.90	1.19	1.73	0.46	0.52
July-13	31	680	16	19.76	1.97	1.23	1.79	0.48	0.53
August-13	31	656	15	19.06	1.97	1.23	1.79	0.48	0.53
September-13	30	616	14	17.90	1.90	1.19	1.73	0.46	0.52
October-13	31	656	15	19.06	1.97	1.23	1.79	0.48	0.53
November-13	30	632	15	18.37	1.90	1.19	1.73	0.46	0.52
December-13	31	664	15	19.29	1.97	1.23	1.79	0.48	0.53

a. Note: the Total Failures of system level is an averages model, so the month on month variation is not captured.
b. As the data gets standardized the Total failures can have the month on month variations in forecasting.

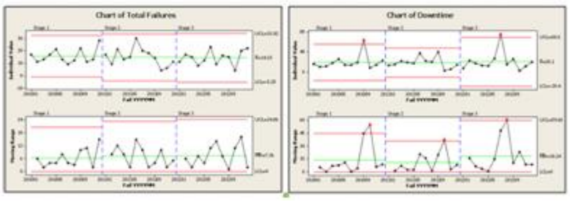

Figure 4: Control chart for failure analysis

a. These charts highlight the Special events.
b. Stages are by Years.
c. Failures Count control chart looks with limits but the Downtime has special events.
d. These special events needs a special attention and should be treated as high risk item.

6. Discussion & Conclusion

- Description of Problem and Cause should be standardized with one entry per one type of problem. May be a drop down options for operator.
- Functional block diagram can help for Hierarchy in Failure categorization
- Once this is Standardized the more failure modes can be modeled and the Total failures forecast will capture more failure modes with higher accuracy and less month on month variation

- Inventory and man power can be managed more efficiently
- Control charts are the tracker for special events and whenever a next special event occurs the operator should raise a high alert flag

7. Future Scope

The evolution of the maintenance process also rooted from changing complexity of the industry itself. Plant Maintenance has become more important in the industry and the role of maintenance grown into a much more prominent purpose in the plant operations [5]. From a simple expectation of keeping an equipment running or restoring it to the desired restoring condition, management saw a much more different role of maintenance.

As the climate of doing business changed, so does the management expectations from plant maintenance department and now maintenance efficiency is considered as an important contributor to business effectiveness [6].

The growth of mechanization, automation and computerization has made machines more complex. The integration of machines on one side has increased the production efficiency but a small breakdown in the whole chain can derail the entire plant production. The reliability of equipment and maintenance is a serious issue. A concept of zero breakdown environment is being thought of. There will be more tilt towards implementation of advanced maintenance tools like TPM, RCM, RCFA , FMEA and customized maintenance support software.

With the rapid development of computer technology, especially in the field of artificial intelligence, These machines will be made more reliable and user specific. The computers will not only monitor machine performance data but also through advanced simulation models will predict future breakdowns and alarm for the corrective action. The future of plant maintenance seems tobe heading towards technology driven initiatives.

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