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# APPLYING DATA MINING FOR ROOT-CAUSE ANALYSIS OF MACHINE FAULTS IN COMPLEX CONTINUOUS PROCESSES

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***Abstract***

*The objective of maintenance is to reduce the number of unexpected breakdowns due to failures, which may be catastrophic and may occur huge loss. Many industrial companies have shifted their maintenance programs to condition-based maintenance (CBM), which, if correctly and effectively implemented, can significantly reduce the maintenance cost. CBM made a continuous health diagnostic of equipment components. One of the main methods used for improving efficiency of maintenance is root-cause analysis of machine faults.*

**Key words :** condition based maintenance, data mining, fault, root-cause analysis

## INTRODUCTION

Machinery maintenance accounts for a large proportion of plant operating costs. Compared with the conventional scheduled maintenance strategy which is to stop the machine at pre-determined intervals, modem condition-based maintenance strategy stops the machine only when there is evidence of impending failure. It is now possible to use multi-modal sensor input to monitor machine condition in a collaborative and distributed manner. Three categories of methods for condition monitoring are important - 1. knowledge based, 2. model based 3. data based methods. Knowledge-based systems are derivations from expert systems that use rules and inference engines to determine failures and their causes. Data-driven methods use machine fault data, typically derived during experiments to train a monitoring system. Pattern recognition algorithms then attempt to classify actual sensor data using the results of the training phase. However it is often impractical to obtain data for every type of fault. Model-based techniques on the other hand use mathematical models to predict machine performance.

Fault diagnosis is an area that has seen some of the earliest applications of data mining. A common and intuitive approach to problem solving is to examine what has happened in the past to better understand the process, then predict and improve the future system performance. Data mining can help in identifying the patterns that lead toward potential failure of manufacturing equipment. The knowledge generated by searching large databases can be integrated with the existing knowledge-based systems to enhance process performance and product improvement.

## MATERIAL AND METHODS

This study concerns the root-cause analysis of faults for the complex acting mechanism which acting all elements of tower diffusion. Tower diffusion (extraction) is equipment mainly in the output of beet sugar in it taking place diffusion sugar beet in solution technology for obtaining the sugar. The tower diffusion and his actuation scheme are presented in figure 1 and in figure 2 is variation of operating parameters of the diffusion tower.

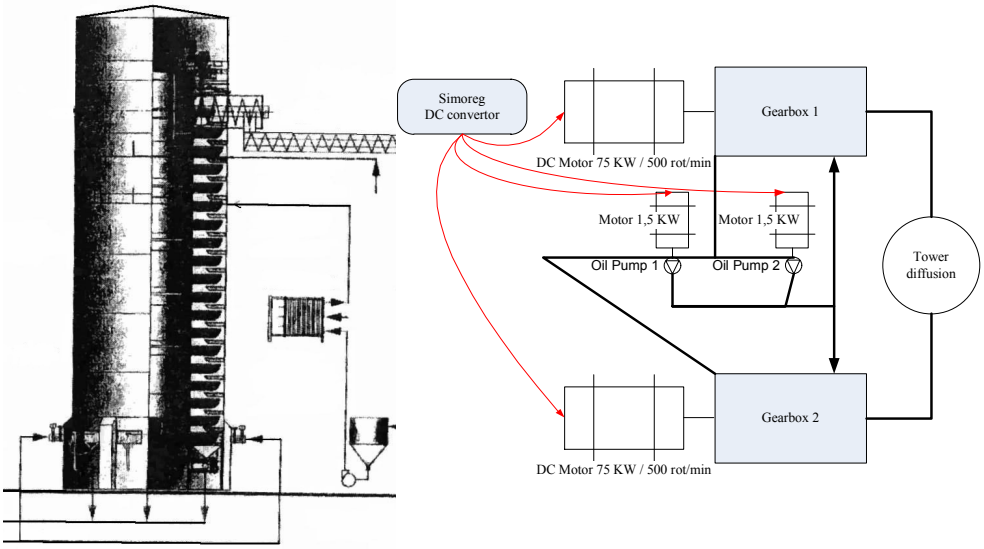
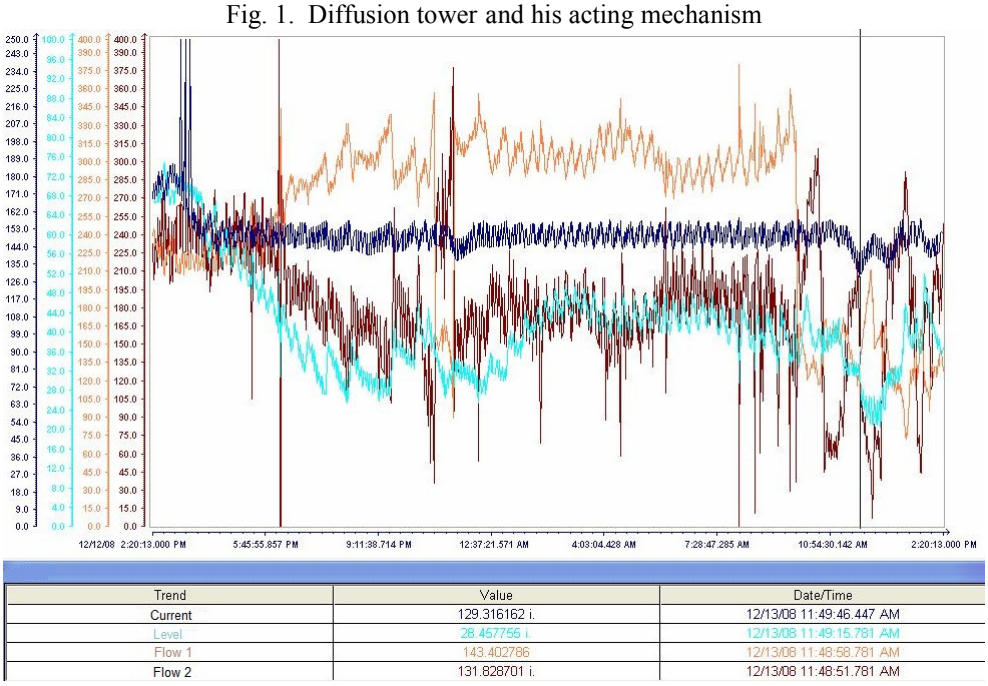



Fig. 1. Diffusion tower and his acting mechanism




| Trend | Value | Date/Time |
|---|---|---|
| Current | 129.316162 i. | 12/13/08 11:49:46.447 AM |
| Level | 28.457755 i. | 12/13/08 11:49:15.781 AM |
| Flow 1 | 143.402786 | 12/13/08 11:48:58.781 AM |
| Flow 2 | 131.828701 i. | 12/13/08 11:48:51.781 AM |

Fig. 2. Variation of operating parameters of the diffusion tower

The analysis system comprises three main steps as shown in figure 3 [11] : 1) root causes analysis (RCA) in case of expected process abnormality; 2) decision support (DS) on corrective actions for process operation and maintenance; 3) time-critical DS for alternative actions.

The system architecture for root-cause analysis of machine faults is presented in figure 4 [11]. The data from diffusion tower senzors and his acting mechanism sensors was stored in Microsoft SQL Server 2000 by the automation software.

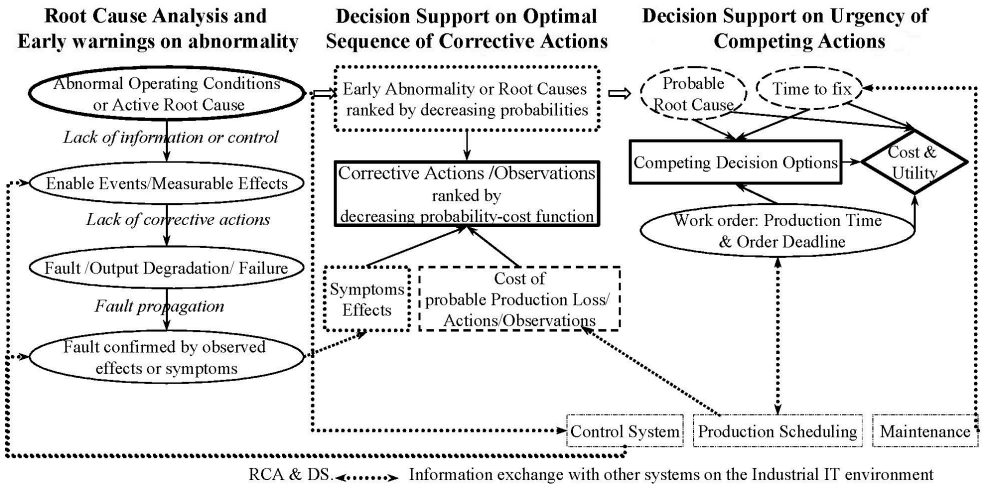



Fig. 3. System for Root Cause Analysis, Decision Support on efficient sequence of Actions and Observations, and DS on Urgency of Competing Actions

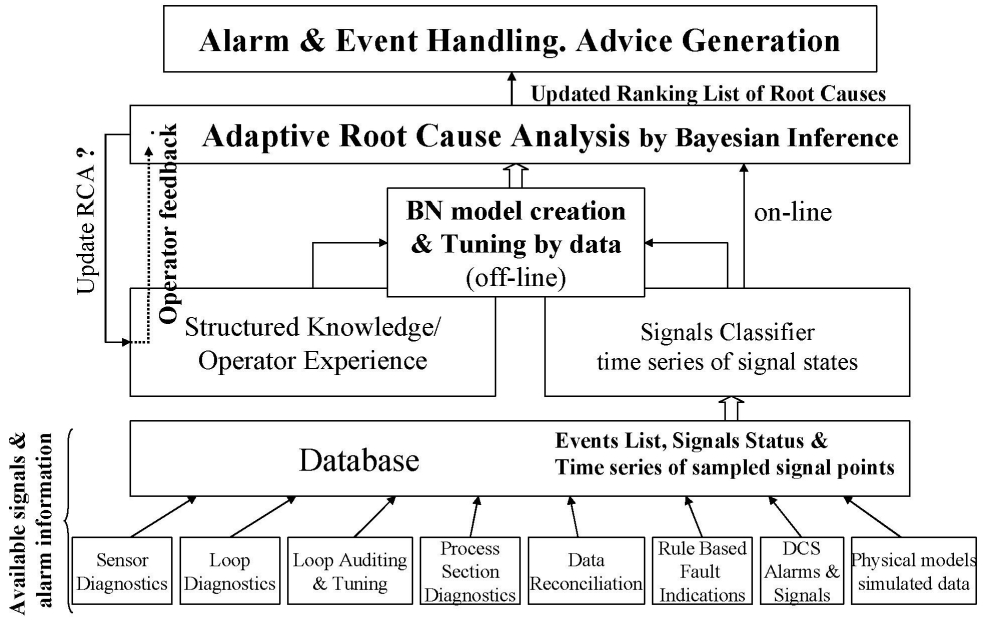



Fig. 4. System architecture for root-cause analysis of machine faults

## RESULTS AND DISCUSSION

After processing data with Microsoft SQL 2008 R2 Data Mining software was established those operating areas of the diffusion tower that overload the acting mechanism. By avoiding these areas, will increase Mean Time Between Failures of the system, so maintenance costs will decrease and the risk of unplanned faults will be minimal.

## CONCLUSIONS

In any real process application, root-cause analysis needs adaptation to incorporate the ongoing changes in process behavior. A suitable adaptation algorithm is the sequential learning with fading. The fading is a convenient feature after maintenance activity on the plant. The sequential learning is performed on the actual root cause nodes and corresponding evidence for that particularly observed case. This is based on feedback from Distributed Control System and on operator / maintenance reports.

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