APPLICATION OF ADVANCED VISUALIZATION & ARTIFICIAL INTELLIGENCE TECHNOLOGY AS A CONDITION MONITORING TOOL

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ABSTRACT

With the rapid technological advancement in the industry, systems are becoming more complex to maintain while faulty detections and diagnostics methods are becoming increasingly difficult with new technological approaches posing challenges for effective machine monitoring and deployment of maintenance strategies.

Most maintenance strategies are deployed manually which means maintenance plans are pre-arranged, and this usually leads to either over maintenance or under maintenance of the asset. Therefore, an advanced optimization of maintenance plans is needed for an improved maintenance procedures and integrated assets management systems.

To overcome these challenges, this paper will introduce some advanced visualization & artificial intelligence technology methods which serve as condition monitoring tools to drive an automated maintenance strategy and it will also show the dominance of the visualization technology method and how it will directly improve production.

Keywords: SAP, Date, PI, Strategies, Maintenance, Tags, AI, CM, CMMS

INTRODUCTION

Advanced visualization technology & artificial intelligence plays an essential role in process automation and data visualization which makes operational data namely historical data, running hours to be represented in a form that is easily understandable, such as curves, diagrams, and historical charts by operations and maintenance personnel alike. Over the years, efforts have been geared towards automating the maintenance processes and availability of critical equipment’s and spares in support of operations, however, most of the maintenance activities are manually planned [1], which means maintenance plans are pre-arranged, which usually lead to either over maintenance (performing maintenance more frequently than desired) or under maintenance (inability to identify chronic failure forms before failure occurs), which leaves less room to identify the failure developing period between a potential failure and a functional failure.

The availability of equipment to meet the operational needs is of critical importance, however, the improper maintenance approach deployed for these equipment's lead to unwanted downtime, extended lead time for parts, safety issues, and the consequence of such impact affects the overall reliability, operational performance and availability of critical equipment's and lead to production loss for the organization.

Therefore, it becomes imperative to introduce an automated maintenance strategy that can lead to effective equipment condition monitoring which can eliminate over and under maintenance plans, downtime and significantly increase equipment's availability, utilization and production.

The visualization system will greatly enhance condition monitoring of assets that tend to detect emerging failures and degradation based on historical operational data trends, this will enable early response and resolution of such failures.

BRIEF INTRODUCTION OF CONDITION MONITORING AND PREDICTIVE MAINTENANCE

As the name implies, condition monitoring (CM) deals with real time monitoring of the health condition of an equipment to ascertain whatever changes that might have occurred and has the potential to affect its safe and reliable operations.

However, condition monitoring which is one of the vital components associated with predictive maintenance has made it possible for operations and maintenance personnel to monitor and report on the true condition of an equipment, as access to such condition monitoring information / data helps in the trending of operational data collected and proffer better solutions to address identified issues [2].

Predictive maintenance (Pd.M.) plays a major role in predicting equipment failures and can be used in obtaining operational parameters such as relative humidity, temperature, heat distribution and other environmental parameters, and this makes it widely acceptable in the industry.

Predictive maintenance (Pd.M.) can be implement using various tools such as condition monitoring for rotation equipment while for fixed and static assets, nondestructive examination and structural health monitoring respectively [2].

EVOLUTION OF MAINTENANCE PLANS

Maintenance planning has evolved over the years, the maintenance strategies deployed can be used to address changes and improvements to the various categories of maintenance which include corrective, preventive, condition base and predictive maintenance.

Before the introduction of sensors in equipment's, the traditional way of obtaining runtime hours and logs was through manual record keeping by technicians and duty holders. This has changed since the advent of built-in machine sensing devices.

The running hours of equipment can now be recorded via real time monitoring through smart sensors, the data gotten are used as input to trigger the various maintenance strategies that have been created prior to generating the readings. A typical maintenance strategy could either be 2000 hours service checks as may be recommended by the manufacturer etc. The notification will be sent out automatedly to the planner / scheduler who will have reasonable time to make all the necessary plans for work execution.

DATA VISUALIZATION AND AUTOMATION OF MAINTENANCE PLANS AND INTERVALS

Advanced visualization technology will help to drive a counter-based maintenance strategy when the set counters have reached a particular reading, for example, perform routine maintenance task every 2000 running hours.

Automated maintenance plan processes eliminate unwanted down time in plan execution, provides real time data on the health status of the equipment and afford a reasonable time to plan out the corrective work that will arise due to the executed plan.

The process of automating maintenance plans involves data extraction, creation of source and instrument tags which are used to extend data to PI data link and creation of SAP PI tags. The peak of the process is the creation of the SAP tags (Computer Maintenance Management System) that enables viewing of various run hours. [6]

Figure.1: Showing visualization of data extracted.

Figure.1 shows the Pi vision tool which is capable of creating dashboards using the data extracted from the equipment’s. The dashboard doesn’t only serve as a reporting tool which shows a high-level view of operational performance data and equipment runtime.

The Pi vision tool also provides input data for reliability and maintainability analysis and calculation of metrics such as MTBF, MTTF, and MTTR. The Pi vision tool also has the capability of creating dash board graphs for easy data crunching and visualization.

REMOTE EXTRACTION OF DATA

Data can be extracted from the piece of equipment via the creation of instrument tags, these tags extract data from the inbuilt smart device installed on the equipment, and in the absence of such smart devices, manual connection can be done by the technician.

The computer maintenance management system (CMMS) enables to gathering of such daily readings which is a combination of the measuring points, measuring documents, measuring time and the 24 hours totalization of the running time created on SAP.

The table below shows the display for the measurement document list with the various data extracted from the piece of equipment via the instrument tags. The reading extracted are totalized for a period of 24 hours as shown in column 5 of the table which gives an accurate flow total.

MEASURING POINT

The readings extracted from the measuring points defines as a condition / measurement at a particular time and these data represents measuring points in the computer maintenance management system (SAP). [5]

The SAP system has the feature for the measuring points which is defined as a location at which condition is designated. The measuring points are usually measured on the equipment or in most cases from the equipment FLOC. An example is the running hours of a compressor; the compressor can be represented via its functional location FLOC-COMP-#1. The running hour device is then created as a measuring point #3264635 for functional location FLOC-COMP-#1.

MEASURING DOCUMENT

The measuring document refers to extracted data transmitted to the system after measurement has been completed at a measuring point in the computer maintenance management system (CMMS). Such transfer can be done automatedly which result in the readings being entered in the system. [5]

Table 1. Showing data extracted from Pi data link & SAP

Measuring point	Measuring Document	Date	Time of measurement	Counter reading
3465643	329249236	22/03/2021	09:00:00	11821
3465643	308459119	21/03/2021	09:00:00	11811
3465643	296076967	20/03/2021	09:00:00	11804
3465643	488720949	19/03/2021	09:00:00	11785
3465643	313618833	18/03/2021	09:00:00	11774
3465643	486822700	17/03/2021	09:00:00	11756
3465643	312180464	16/03/2021	09:00:00	11740
3465643	364618746	15/03/2021	09:00:00	11735
3465643	482199885	14/03/2021	09:00:00	11735
3465643	398699670	13/03/2021	09:00:00	11713
3465643	441459329	12/03/2021	09:00:00	11701
3465643	241103287	11/03/2021	09:00:00	11677
3465643	389959225	10/03/2021	09:00:00	11669
3465643	254595003	09/03/2021	09:00:00	11649
3465643	416023945	08/03/2021	09:00:00	11649
3465643	295727322	07/03/2021	09:00:00	11645
3465643	308855128	06/03/2021	09:00:00	11632
3465643	425922640	05/03/2021	09:00:00	11623
3465643	218578910	04/03/2021	09:00:00	11616
3465643	468026260	03/03/2021	09:00:00	11616
3465643	433805690	02/03/2021	09:00:00	11595
3465643	257458009	01/03/2021	09:00:00	11590
3465643	325186807	28/02/2021	09:00:00	11568
3465643	427110171	27/02/2021	09:00:00	11555
3465643	296505078	26/02/2021	09:00:00	11551

IMPROVING PI DATA COLLECTION VIA ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) has been around for decades, with early development in gaming AI. AI research work dates back to the early 1960s but did not gain much recognition until decades later, these technologies were only available in computer labs and other significant research organizations, and they required computers with good computing capability to function.

AI in the workplace has become a reality thanks to remarkable technological advancements over the years, it began slowly but quickly gathered traction, it is now widespread and presents itself in a variety of ways. It has had a considerable impact on the industrial workplace over the last two decades, however, bridging the gap between AI technology and human understanding remains a difficulty. There must be a human conduit across this industry-changing technology in order to get the most out of AI.

This technology has been greatly instrumental in the development of Engineering technology, and is now used to train use cases of operational data collected.

In the case of Pi where the primary purpose is to develop condition monitoring of industrial assets such as turbines, pumps, compressors, etc., which is done by collecting data from these assets and ensuring that the right data is collected for Engineering analysis.

The AI component of Pi comes in handy in improving what future data is collect by making use of previously collected data and ensuring that the sensing systems used are capturing the targeted data needed for predictive maintenance [4].

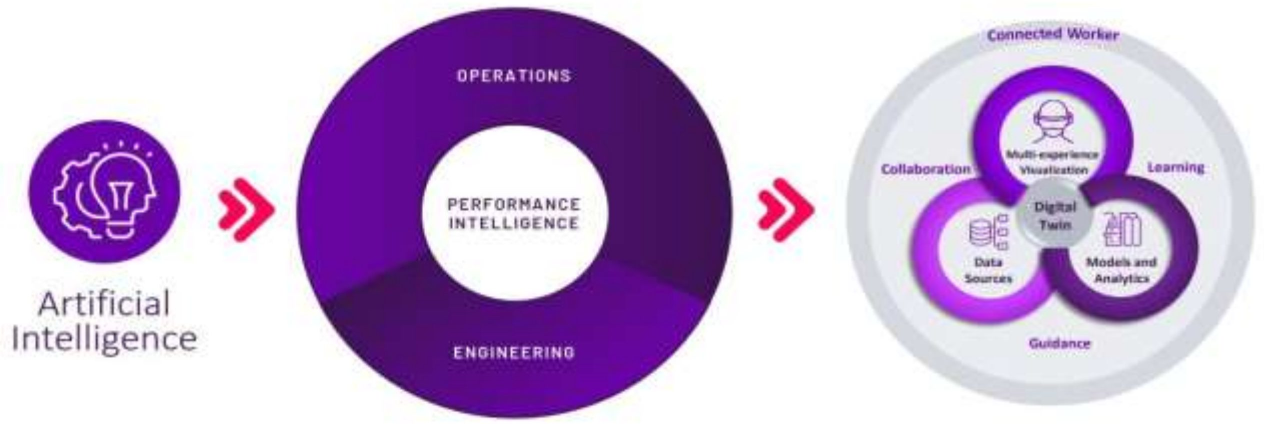

Figure 2: Showing the connection between AI and other segments of Pi.

Fig 2 above shows the link between AI and how it's directly related to improving operational performance via performance intelligence and engineering analytics optimization. The collection and visualization of data through Pi and the improvement of algorithms will be incomplete without human intervention, as the complete process involves data collection, processing, storage, visualization and defect identification by a visual analytics specialist who can apply engineering knowledge in identifying inconsistent data and will recommend which inspection areas are lacking, to enable the AI team identify which use cases to be utilized in the AI training environment [4].

CONCLUSION

This paper has been able to describe the recent trends in relation to data extraction from heavy machineries and the visualization of the data via a user interphase, this simple but efficient process has laid the foundation for maintenance automation and has proven to be efficient in minimizing maintenance scheduling errors and downtime.

The presence of built-in sensors in equipment's such as pumps and compressors continue to make it possible for remote data collection, however, this capability is mostly available in more recent assets built with the highest level of cutting-edge machine vision technology.

This technological intervention has also made it possible for companies to save cost, improve data accuracy and minimize the need for manual data collection. The use of data extraction and visualization tools by developers such as Osisoft has also featured as a game changer, the application of these tools are not only limited to the collection of runtime data, but are also able to extract vibration data such as acceleration and velocity, which is used as input data to estimate the frequency of vibration which can be used to optimize condition monitoring of assets.

The recorded frequency of vibration can be low or high frequency, depending on the failure mechanism that is being captured. This paper also established the effectiveness of pi data link tool and its role is ensuring that equipment routine inspection and maintenance can now be scheduled for when maintenance is actually due, rather than going by what is stated in the OEM manuals and in scheduled maintenance documents that were developed based on past experience and preliminary engineering analysis.

The AI segment is also not left out, as it has a part to play in improving data collection via training of use cases and improving how future data is collect by making use of previously collected data and ensuring that the sensing systems used are capturing the targeted data needed for condition monitoring.

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