Trendy a inovatívne prístupy v podnikových procesoch „2018“, roč. 21
Trends and InnovativeApproaches in BusinessProcesses “2018”, Vol. 21

TOOLS TO SUPPORT INTEGRATED MAINTENANCE

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Abstract: From the perspective of practice, maintenance is carried out to ensure the desired reliability of production systems so that the total cost of the operation of such systems are the lowest. The article describes the need for integration of complex system maintenance and its prospects. The paper describes the approaches, starting points and methods of integration. It presents the architecture and the basic concepts of an integration platform, which constitutes the framework of systems implementing the tasks dedicated to remote maintenance, as well as other applications, for large and medium scale industrial installation.
Keywords: Maintenance, integration, complex system, failure.

Introduction

In today’s competitive market, production costs, lead time and optimal machine utilization are crucial values for companies. Since machine or process breakdowns severely limit their effectiveness, methods are needed to predict products’ life expectancy. Furthermore, information about the remaining life of products and their components is crucial for their disassembly and reuse, which in turn leads to a more efficient and environmentally friendly usage of products and resources. Development of the Watchdog AgentTM answers the needs for enabling predictive condition-based maintenance of the product and/or its disassembly and reuse in another system through enabling multi-sensor performance assessment and prediction.

Defining the problem

The performance of machines and equipment degrades as a result of aging and wear, which decrease performance reliability and increase the potential for faults and failures. At the same time, the products and services must be of the highest quality to attain and retain a favourable market position. For example, one minute of downtime in an automotive manufacturing plant could cost as much as $20,000. Near-zero downtime and highest possible quality are fast becoming a necessity for both service and production enterprises.
Reactive maintenance, performed only when equipment fails, results in both high production costs and significant service downtime caused by equipment and process breakdowns. On the other hand, preventative maintenance is intended to eliminate machine or process breakdowns and downtimes through maintenance operations scheduled regardless of the actual state of the machine or process. Preventative maintenance intervals are determined using reliability theory and information about the machine or process lifecycle. This practice often results in an unnecessary loss of productivity either because maintenance is performed when the process or machine is still functioning at an acceptable level or because unanticipated breakdowns occur before scheduled maintenance operations are performed.
Therefore, in contemporary markets, it becomes increasingly important to predict and prevent failures based on the current and past behaviour of the equipment, thus ensuring its maintenance only when needed and exactly when needed. For these reasons, we propose a paradigm shift from the traditional approaches of detecting and quantifying failure toward an approach centred around assessment and prediction the performance degradation of a process, machine, or service [1]. Performance degradation is a harbinger of system failure, so it can be

used to predict unacceptable system performance (in a process, machine or service) before it occurs. The traditional Fail and Fix practice can thus be replaced by the new Predict and Prevent paradigm.

Describing activity in process of maintenance

Integration of the maintenance system is based on the use of modern systems in the field of maintenance management. For integration of the maintenance system it is crucial to find the connection between data from diverse areas and establish coherence and dependence between them. Nowadays, the management of maintenance processes using mainly IT technologies.
Operation of large enterprises requiring large amounts of closely related activities. These activities requires highly specialized assistance from IT systems. High traffic operates as a whole more effectively when it has an information system that supports business in all activities. Especially in utilities companies are needed to numerous, highly specialized operations that include maintenance, logistical support, control and finance. That system has been building gradually by the company itself, because there is no universal system that would meet the company one hundred percent. With hindsight, the system becomes inflexible and difficult to further expansion, without the possibility to access data that is not on the surface. Another approach to creating an information system is purchase application with the necessary functions from specialist suppliers. That systems operate as isolated islands, which must be gradually interconnect. Over time, the amount of links raised and creates a confusing image, what in the long term increased maintenance costs and changes in that system. Here is requested finalize integration by system of maintenance control process supported by computer technology and process of integration of maintenance performance immediate realized person (Fig. 1).

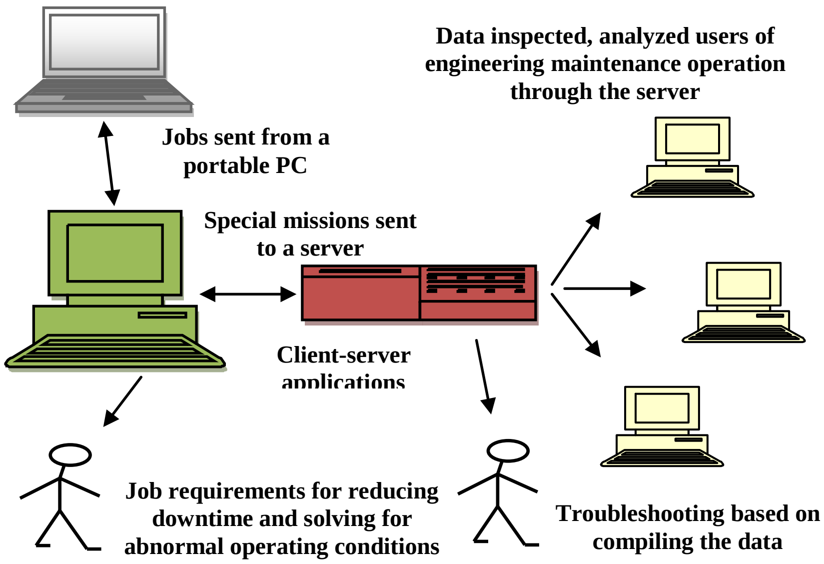

Fig. 1 Describing activity in process of maintenance in terms of integration

Intention and objectives of integration

Integration of maintenance into manufacturing organization is partitioned into "hard integration" and "soft integration" variables. The "hard" issues deal with integration supported by technology and computers. "Soft" integration, on the other hand, deals with human and work organizational integration issues. The two integration variables are closely related to the prevention variable, and are considered important enablers for effective realization of preventive policies [1]. Integration must facilitate the bidirectional flow of data and information into the decision-making and planning process at all levels. This reaches from business systems right down to sensor level.

Hard maintenance integration issues deal with CMMS (Computerised Maintenance Management System) of the maintenance, repair and operating supplies store and scheduling of maintenance work, condition monitoring technologies, built-in test equipment, databases with reliability data on electronic and mechanical components, and decision support. On the other hand, soft integration issues of maintenance deal with the structure and the actors in the organization. New technology allows plants to have fewer humans directly participating in the physical manufacturing processes.

To integrate maintenance policies and study their impact on complex production systems, a powerful modelling tool is essential. One (or more) maintenance policies may be associated with each machine. Thus, an elementary cell is defined as a set made up of a machine, including associated maintenance policies, as well as its input/output stocks. Maintenance Integration is necessary to increase availability and reliability of manufacturing systems to reduce unnecessary investment in maintenance without great increasing of investment. The integration is achieved through combining optimal maintenance types to have the benefits and to avoid the shortage of individual maintenance types. Thus, the proper maintenance program must define different maintenance plans for different machines.

The literature survey of the related works indicates that a major interest of researchers has been the maintenance optimization not causing a measurable response from the engineering world due to two reasons:

1) Applicability: The works were mostly very theoretical, used difficult mathematics impractical to apply and required data were not then generally available.
2) Accessibility: The papers were published in journals of applied mathematics and operations research (OR), which most maintenance engineers do not read and few would understand if they did.

Thus, maintenance methods applied at present should be combined together within a comprehensive management maintenance system, which would permanently monitor the system and suggest the most appropriate actions. Thus, the scheme proposed herein serves this purpose, i. e. it combines maintenance integration and neural management maintenance system.

The key words then became “integration”, “computer integrated manufacturing”, “openness and open systems”, “interoperability”. Some technologies have seriously contributed to this approach. Firstly, the networking capabilities with the MAP project [1] early in the 1980s, and then with field buses [2], The decreasing cost of electronics and the increasing number of controllers, computers, and PLCs in all the machines, in all the equipment, in all the activities have also made their contribution.

But this is not enough. Technology provides certain capabilities, but to reach the objective of global optimization there needs to be more than technology. Models are needed, and in this field, the complexity of the concerned systems (an enterprise) and the heterogeneity of the existing models make this modelling difficult.

The components of maintenance and their integration

Any industrial enterprise represents a lot of activities, from marketing, design of the products, and manufacturing, to commercial service, management and financing. These activities have been studied for a long time with one main global objective, their optimization. This, of course, would be followed by an increase in profits. The other advantages resulting from this optimization include: better quality of production, greater output, better training of operators, innovation of a product, better commercial service, financially optimal investments, and so on. This is the main reason why, for a number of decades, each activity and service of an enterprise was the object of modelling and formalization, and, according to the variety of activities, the number of models and of modelling techniques proved to be great. But after having optimized the different services of an enterprise, essentially thanks to information technology and the different theories of automatic control and optimization, it appeared that global optimization needed other approaches, other theories and other tools. The key words then became “integration”, “computer integrated manufacturing”, “openness and open systems”, “interoperability”. Some technologies have seriously contributed to this approach. Firstly, the networking capabilities with the MAP project [1] early in the 1980s, and then with field buses [2], The decreasing cost of electronics and the increasing number of controllers, computers, and PLCs in all the machines, in all the equipment, in all the activities have also made their contribution.

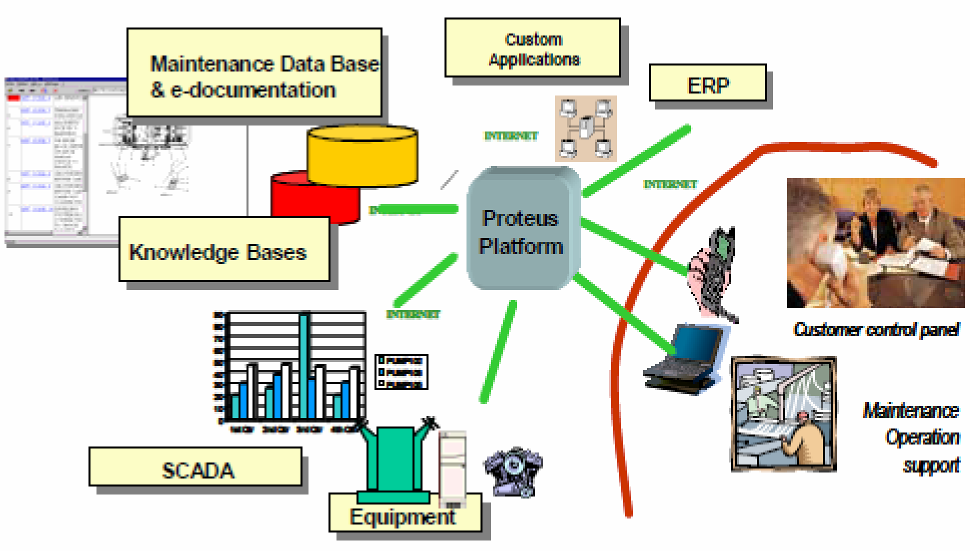

Fig. 2 Overall maintenance components

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The original idea of the PROTEUS project (Fig. 2) dedicated to industrial maintenance lies in the integration of all the necessary tools whose functions range from the detection of alarms to the management of spare parts, with the purpose of optimizing costs and improving productivity. This optimization can be seen as the extension of the automatic control principles throughout the entire enterprise, in particular the “closed loop” concept applied to the production process.

Indeed, maintenance is a very important activity for all industrial enterprises, for improving product quality, production output, and customer satisfaction. Maintenance covers all domains of an enterprise, from the plant and the equipment to be maintained, to the organization according to different strategies (preventive maintenance, predictive maintenance, corrective maintenance), to managing operators and material (handling, hoisting) and spare parts, to the computer aided diagnostic systems, to documentation management and so on.
Maintenance is then an activity which needs the integration of several sub-systems associated with the different previous functions involved in maintenance operations. All these software sub-systems are currently based on different models; they are normally complementary, but sometimes redundant, sometimes incoherent and always heterogeneous.

Conclusion

In today’s landscape of maintenance support tools, few truly integrated systems exist. However, the enabling technologies for building a global platform are there, on the market, or within the capabilities of integrators. The major technological trends currently observed promote the use of Internet communication technology and distributed object-oriented processing environments to provide the necessary integration of previously isolated sub-systems. This paper takes its inspiration from these trends in order to promote progress and innovation in the domain of integrated maintenance systems.

References

[1] BANGEMANN, T., et al.: PROTEUS—Creating distributed maintenance systems through an integration platform. Computers in industry, Volume 57, Issue 6, August 2006, Pages 539-551.

[2] BEN-DAYA, M.; DUFFUAA, S.O.; RAOUF, A.; KNEZEVIC, J.; AIT-KADI, D.: Handbook of Maintenance Managementand Engineering. Springer Dordrecht Heidelberg London New York 2009. 741 p. 330 illus. ISBN 978-1-84882-471-3 e-ISBN 978-1-84882-472-0.

[3] DJURDJANOVIC, D, NI, J. AND LEE, J., 2002, “Time- Frequency Based Sensor Fusion in the ssessment and Monitoring of Machine Performance Degradation”, to appear in the Proc. of 2002 ASME Int. Mechanical Eng. Congress and Exposition, paper number IMECE2002-32032.

[4] SMITH, R., HAWKINS, B.: Lean Maintenance, reduce costs, improve quality, and increase market share. Elsevier Butterworth–Heinemann, 200 Wheeler Road, Burlington, MA 01803, USA, 2004, 287 s., ISBN: 0-7506-7779-1.

[5] VALENČÍK, Š., STEJSKAL, T.: Údržba, diagnostika a opravy strojov. EVaOL Strojnícka fakulta TU Košice, Košice 2015, 240 s., ISBN 978-80-533-2249-0.

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