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# SOFTWARE SUPPORT FOR THE MANAGEMENT OF LUBRICATION

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**Abstract:** *This paper presents a software package LMSoft that automate the process of lubrication management of technical systems that is a part of the information system of preventive maintenance. Featured software package is the result of years of research by the field of information systems and the design of control systems in the process industry. The function of preventive maintenance is increasingly represented in a new form known as proactive maintenance processes where lubrication play a key role. Processes include lubrication and periodic quality control of lubricating oil, the results represent a significant technical support to the technical diagnostics. By automating management processes at the same time improving lubrication preventive maintenance and technical diagnostics.*
**Keywords:** *software support, lubrication management, preventative maintenance, technical diagnostics*

## INTRODUCTION

Software package for managing processes lubrication LMSOFT (Lubricant Management Software) is designed to support organizations with different profiles that have technical systems with a large total number of lubrication where manual control was very difficult and unprofitable. The software package includes a database that is used to manage the process of preventive maintenance, and also for storing the results of technical diagnostics. Technical diagnostics and lubrication are key elements of preventive maintenance, which are modeled using FMEA (Failure Modes and Effects Analysis) methods. FMEA method is used in the LMSOFT in a particular area of the real work to identify all of the lubrication and to store the relevant attributes in the database.

## MAINTENANCE – CONCEPTS AND TECHNOLOGIES

Maintenance of the technical systems (TS) represents a set of procedures and activities which is main purpose to prevent states of failure and recovering from fails to the state of normal work in the shortest possible time and with less expenditure in the given environmental conditions and work organization. The purpose of maintenance is to increase the effectiveness of the production process, which will result, that costs per unit of production will decrease. Maintenance TS should be considered as a function of the primary production, because it contributes to the production to takes place in a rational manner with optimum reliability level of TS in the company [1].

Basic concepts of maintenance include: preventive, corrective (reactive) and combined maintenance. Preventive maintenance, which aims to prevent or delay the occurrence of failure, can be implemented in several ways.

By default, two basic types of preventive maintenance [2]:

– The first case refers to the periodic preventive maintenance that is based on information on the reliability of the system (division of the time of work until failures of the observed system or part).

– The second case, also known as maintenance of the state or predictive maintenance is based on the monitoring of parameters that represent the state of the observed system.

Predictive maintenance resulting in the reduction of the number of unexpected failures, increasing

reliability and reducing direct and indirect costs of maintaining TS [B]. A latest innovation in the field of predictive maintenance is the so-called proactive maintenance, where various technologies are used in order to extend the life of the machine and for the practical elimination of corrective maintenance. The main part of the program is a proactive analysis of the causes of failure of machinery or part thereof. The causes of the failure of the machines in this way can be removed, and the failure mechanisms gradually will be eliminated with engineering approach. Corrective maintenance is maintenance concept, which means that maintenance procedures are carried out only when there is a failure occurrence.

Combined maintenance is implemented as a part of the plant maintains preventative, while the remaining part of the maintenance procedures carried out as it comes to failure. Choice of area of preventive and corrective maintenance of all technical systems is in function of optimization in order to reduce the maintenance costs of the product [3]. Maintenance technology is directly linked to the development and production technology, and contains procedures and ways of their implementation, including [4,5]:

– basic maintenance by the operator,
– preventive periodic inspection and replacement of parts,
– random inspections regulated by the regulations and laws,
– lubrication of the technical system,
– technical diagnostics (determining the actual state of the system),
– repair and restore of the worn parts,
– identification and elimination of the weak points of the system (innovation) and
– general periodic repairs and modernization.

For the implementation of the maintenance technology it is necessary to have a clear concept that contain answers to many questions: When is a need for maintenance, why is maintenance carried out, what procedure should be used and in what order, in what part of the system maintenance works should be carried out, who will be the perpetrators [6].

## TECHNICAL DIAGNOSTICS
Determining the condition of the machines is a key issue in the process of its maintenance. It is necessary to monitor changes in the condition of individual parameters of components and machine elements, which eventually lead to a drop in performance and to failure. Technical diagnostics (TD) checks the correctness of the TS, TD checks the working capacity of the TS, TD checks the functionality of the TS. Diagnostic controls are divided in to the next sections [7]:

– Identification of the working state – the state assessment using appropriate instruments and observation with predefined criteria permitted and illicit states of the TS,
– Maintain of the working condition Analyzing the state of the TS according to a scheduled program and taking the actions to reduce the probability of the failure,
– Preventive examinations - periodic testing of the TS, microclimate, vibration, noise, etc.

For the application of the technical diagnostics there are basically two forms available:

a) on-line diagnosis (diagnostic devices are built into the machine, an estimation of the state of the key parts is performed in the run time and it is based on the measured parameters);

b) off-line diagnosis (diagnostic measures are implemented after some time the system was in working state, a machine may be excluded from the process of the work.

## FMEA - FAILURE MODES AND EFFECTS ANALYSIS
FMEA (Failure Modes and Effects Analysis) is a procedure for analysis of potential failure in the system and their impact on the system and focuses on the prevention and reduction opportunities that cancellation occurs. It is used to detect and prevent problems in the process before they arise.

FMEA method involves a disciplined and detailed analysis of the processes and the systems (system, subsystem, assembly or component). For the final assessment of the risks of the potential damages it is necessary to estimate the probability that they will occur. Basic terms used in the FMEA are:

– Failure of the system (subsystems, assemblies or components) – inability of the system to perform the function,

− *Form of the system failure - form or the condition of the element after the failure,*

− *The cause of the system failure - a process or mechanism responsible for the initiation and failure,*

− *Effect of the system failure - a consequence of the failure to function or system status.*

*The basic concept of the FMEA method involves decomposition of the system into its constituent elements, to a level that is estimated to be significant in the analysis. FMEA method is implemented in to the worksheets that can take many forms and elements, depending on the system being analyzed and the purpose of the analysis.*

*The final FMEA method is to determine the RPN - Risk Priority Number:*

− *Assess severity (Severity - S) of each of the potential impact of the cancellation,*

− *To assess the probability of occurrence (Occurrence - A) Effect of the cancellation,*

− *To assess the probability of detection (Detection - D) effect of each failure.*

*RPN is obtained as the product S x O x D, where S, O and D rated value for a particular job.*

## LUBRICATION MANAGEMENT

*Appliance of the Information technology (IT) in the maintenance / lubrication in order to improve the performance of the TS has become a necessity. Lubrication engineers analysis equipment, its components and guidance to reach the recommended lubricant.*

*After collecting and processing the data of the TS, the lubrication points and lubricant, the main tasks are development plans of lubrication and preventive screenings. In order to achieve the effective lubrication plans it is necessary to create the conditions for organized planning lubrication to grow into the management with computer support. Lubrication Management is based on the planning and implementation of plans of the lubrication. Monitoring the state parameters can be carried out continuously or periodically, and for each parameter condition it is necessary to determine a value of a cancellation. In this way it is achieved a preventive lubrication that meets most practical situations and types of technical systems [8].*

*However, lubrication management is a much broader process. It includes activities:*

− *Forecasting and prediction,*

− *Planning,*

− *Carrying out and coordinating the actions of a lubrication,*

− *Control deadlines and quality of execution of actions lubrication,*

− *Control the actual system performance and*

− *Control of the cost of lubrication.*

*Planning is a key function of a lubrication management. Lubrication plan must comply with the maintenance schedule / production.*

## LMSoft - STRUCTURE AND FUNCTION

### Customer requirements

*Software Package Management lubrication should provide, at a minimum:*

− *Entering, deleting and editing the data about technical systems, lubricants and lubrication points*

− *Integrated view of the relevant data sets,*

− *Selection of a different search options for the database,*

− *Extend the database with new tables,*

− *Adaptation of the existing search options,*

− *Creation of a new types of searches and masks to show their results,*

− *Distribution of the data,*

− *Creation of a different reports (documents),*

− *Protection of the data from unauthorized access and incorrect entry and*

− *Ease of training and use of the program.*

### Database

*The main goal of a database design is to provide quick and full access to all of the technical systems, lubricants and lubrication points and to provide a support in the management of lubrication using a computer.*

*One of the most important tasks of the preventive maintenance is lubrication, which requires the study of the technical documentation, equipment and instructions for lubricating and finally selection of appropriate lubricants. Database for lubrication management include tables correspond key entities, such as lubricants, technical systems of lubrication, specifications, classifications, quality levels, lubrication maps, orders. These*

tables, together with tables containing systematized results of FMEA method applied to the infrastructure to be maintained (machines, production lines, transport sredatva, equipment, ...) are the basic structure of the database maintenance scheme. The database represent an abstract model of the real system [9].

**THE PRESENTATION SOFTWARE**

**The main form** – *Communication between users and the application is realized through a set of a different forms. In that set we can distinguish a subsets of a forms that are characterized by a similar use: forms of presentation of search results, entry forms, delete and edit data forms, as well as a smaller number of forms to navigate additional choices and a variety of informational and warning messages.*

*Starting from the main form (Figure 1), we will present the structure and functionality of the software package LMSOFT. The main form allows the passage to the basic software functions that cover the user requirements. The main menu contains nine fields / buttons by which we come to associate the form described below. The tenth button closes the program.*



Figure 1. The main form LMSoft

**Form of the technical systems** - *provides evidence of the TS with all relevant attributes such as: Name, Type, Brand, Manufacturer, Lubrication points, Owner. The TS evidence means filling the*

basic information about TS to their records in to the database. This data, later, can be used in the operational work. Using this form you can enter information about the technical system, view and / or edit existing ones, delete and add new information about TS and conduct searches. In the subform the selection of lubrication points can be selected for a specific TS (Figure 2).
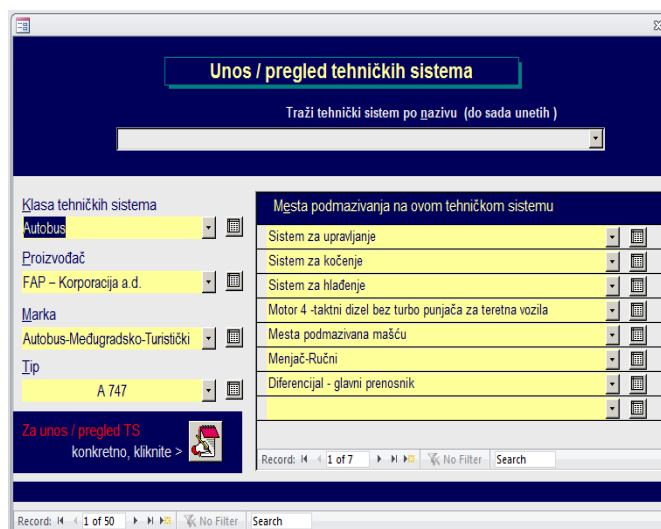


Figure 2. Form input / review TS

**Form Lubricants** - *It is obvious that the choice of lubricant is one of the main input into the drafting process of lubrication. To ensure that this step in the process of lubricating is done correctly and efficiently it is neccesary to ensure:*

- *Fast access to data on lubricants,*
- *Display of all important data on lubricants for lubrication TS, and*
- *Selection of appropriate lubricants for lubrication points of each TS.*
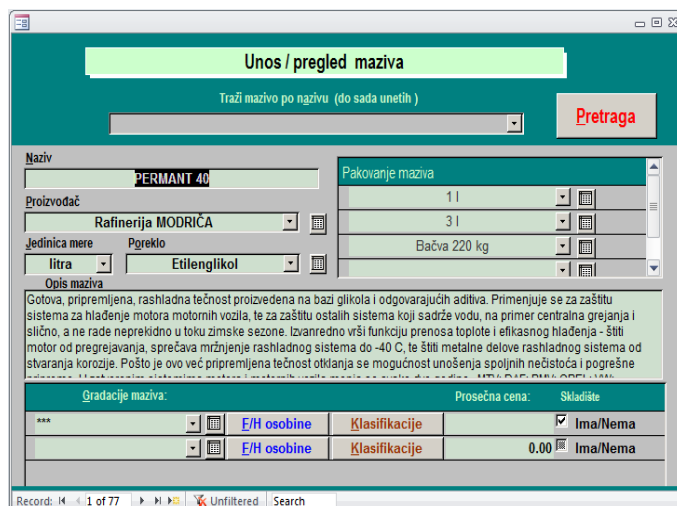


Figure 3. Form input / review of lubricants

Information about lubricants are primarily related to the classification of quality levels, specifications, standards, and other attributes relevant to the lubrication process. (Figure 3).

**Ticket lubrication form** - From the main menu, you enter into a form called Map of lubrication, where, depending on the type of a technical system, selects lubricant and its gradation for each place of lubrication. On this form are available basic data on the TS: name, group, manufacturer, model, manufacturer's number, year of manufacture, operation, pictures, of lubrication.

Lubrication operation includes records about lubrication, lubricants quantity, working hours (kilometers traveled) and the comments. Form has an option for a quick overview of expenditure of lubricant for each TS and all of lubrication.

**Work Order field** - Lubrication Engineer develops a plan of lubrication (lubrication routes) that are executed in the future. Lubrication plan is executed through the Order of lubrication, which has more options (open, in operation, closed). Form contains a button to view your account.

**Report field** - There are several types of reports relating to the consumption of lubricants and lubrication points by selecting the four time periods (random, monthly, yearly and overall). The available and the list of activities lubrication list by TS drives, sectors, facilities and places where lubrication is observed increased consumption of lubricants.

Form includes fields for diagnostics: analysis / test lubricants, limitations of the analyzes, the analysis of lubrication points, restrictions on service conditions and typical values for field analysis (declared by the lubricant manufacturer - catalog value).

**Catalog of lubricants** - Any factory that produces lubricants has a catalog of their products, which describes in a detail the composition, application and other important properties of lubricants. The key advantage of electronic catalogs is reflected in the speed and capabilities of different criteria and procedures for the database search.

## CONCLUSION

Technical diagnostics and lubrication are key processes of maintenance system, regardless of the adopted concept and technology maintenance. On the other hand, the results of periodic control lubricants used in TS, with established critical limits for individual characteristics are important elements of technical diagnostics.

Contemporary concepts of maintenance include proactive maintenance computer aided classified in the production function. Maintenance costs are thus treated as production costs, so the cost of lubrication is directly involved in the pricing of products.

We come to the simple conclusion that the use of the software package LMSOFT directly affect the price of the product. Software support for a process lubrication maintenance management represent a module of a IS, which is opened to connect with the environment, such as a software for the laboratory analysis, software for the warehouse management, etc.

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