Improving service agricultural and forestry machinery

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Abstract. The possible improvement of service maintenance for various agricultural and forestry equipment, which determines the economic efficiency of the enterprise, is considered. The main types of vehicle diagnostic systems using a diagnostic scanner, dealership and manufacturer are given. It has been established that there is a tendency for the machine manufacturer to constantly monitor the main indicators of the machine (both technical and operational) by collecting information, analyzing it and transferring it to the dealer for prompt setup or repair using specialized software, which allows maintaining the equipment in working condition, without causing serious breakdowns and downtime. It is shown that in the case of using equipment from different manufacturers, an enterprise is faced with the problem of the complexity of using information about the machines in use within the framework of a unified information system. To solve this problem, it is proposed to use specially developed maintenance and repair management systems with their integration into a unified digital environment of the enterprise, based on the use of the ERP standard.

1 Introduction

Currently, enterprises in various industries, including the agricultural, logging and road construction complexes, are faced with the rather acute problem of improving the management of the technical condition of machines, maintaining them in technically sound condition at minimal cost. Activities to achieve this include diagnostics, maintenance and timely repairs. Management of maintenance of machinery and equipment at enterprises is traditionally carried out in accordance with the planned preventive maintenance and repair system. However, at present, other systems are also used, for example, the method of scheduled diagnostic repair, in which scheduled periodic maintenance is carried out with monitoring the technical condition of machines [1, 2, 3]. A number of other systems are also used to provide technical service management and reliability-oriented management (RCM) [4], risk prevention (RBI) [5], and condition-based repairs [6, 7]. This situation indicates a search for ways to improve, which is important when operating machines on the road, at facilities located far from the enterprise's repair base. Therefore, it is recommended to use a

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"condition-based repair" system [8, 9], but this requires widespread introduction of a digital diagnostic system into the machine design and a change in the traditional approach to achieve the highest possible serviceable condition of machines. The purpose of the work is to assess the applicability of modern digital technologies for managing the technical condition of agricultural and forestry equipment.

2 Materials and methods

The article discusses the improvement of management of the technical condition of agricultural and forestry equipment using digital technologies. For this purpose, an analysis of the operation of machine diagnostic systems and the possibility of their integration into a technical service management system using modern software products was carried out. Solving the problem of maintaining the operability of agricultural and forestry equipment at enterprises is complicated by the need to take into account a large number of factors: features of working conditions, the actual technical condition of the machines, available repair capacities, the level of qualifications of employees, the availability of spare parts and materials [10, 11], and therefore requires significant management resources. To effectively manage the technical condition of a machine, it is necessary to have information about the state of its components and assemblies, which requires the presence of an on-board diagnostic system. Initially, the task of diagnosing the condition of the components and assemblies of the machine was solved by storing an error code in the memory of the control and alarm unit for the driver; reading fault codes (DTC) was carried out by connecting a diagnostic scanner at the dealer's enterprise, which carried out diagnostics, processed the received information and carried out repairs (Figure 1, a). However, information about malfunctions, especially when the machines began to be widely used, reached both the dealer and especially the manufacturer very late, which led to additional equipment downtime, increased repair costs, and did not allow the machine manufacturer to timely develop measures for its effective elimination. The development of the electronics element base and the acceleration of information transfer created the prerequisites for machine manufacturers, which made it possible, when diagnosing machines at a dealership, to transfer data directly to the manufacturer's server and receive corrective data loaded into the machine's control unit (Figure 1, b). In this case, the dealer was needed as a link creating session access between the machine's control unit and the manufacturer's server. However, such an organization of the diagnostic system is not without its drawbacks; one of the main ones is periodic monitoring of the condition of the components and assemblies of the machine; the time interval depends on the frequency of maintenance. This approach does not allow assessing the technical condition of machine components and assemblies in real time, which can lead to its failure and machine downtime, which reduces the efficiency of use of both an individual machine and the enterprise as a whole. Taking into account the widespread development of information technologies, the deployment of high-speed mobile networks and their wide coverage, the widespread use of Internet of Things (IoT) technology, the development of the concept of digital twins, big data, made it possible to change the approach to monitoring the technical condition of machines and organize it in real time [12, 13, 14, 15]. A modern approach to organizing servicing of industrial machines (agricultural, logging, road construction and others) involves planning maintenance and repair operations based on constant monitoring of its condition. Diagnostic information from the machine, through the use of telecommunications equipment, is automatically sent to the manufacturer's server, where changes in the state of components and assemblies are stored and predicted. If technical impact on the machine is necessary, the dealer gets access to this information and contacts the owner to propose corrective actions (Figure 1, c). The machine owner can also access information about his machine to analyse its performance.

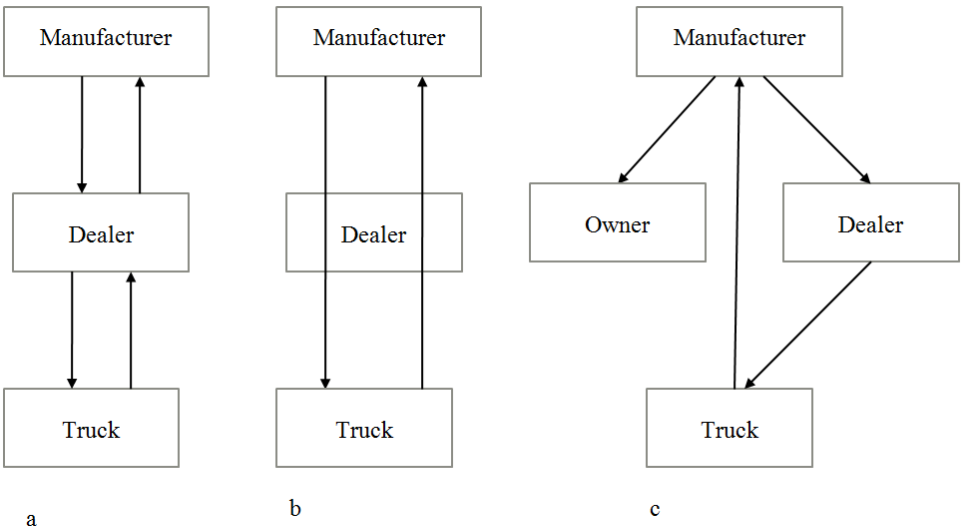

Fig. 1. Transformation of the approach to the use of a machine diagnostic system:

a - original, b - modern, c - promising

3 Results and discussion

The widespread introduction of digital technologies into the activities of agricultural [16, 17], logging [18, 19], construction and other enterprises [20, 21] makes it possible to more effectively plan the maintenance of equipment, as well as manage all production processes. Major manufacturers of agricultural machinery, such as New Holland, John Deere and a number of others [17] and forestry equipment, for example Ponsse, John Deere, Komatsu [19], use their own software products to develop the concept of service maintenance for equipment: for example, the Ponsse company uses the program Fleet Manager, Kamatsu organizes this process using the Max-iFleet program, John Deere uses the TimberLink application, which allows you to manage both the company's logging and agricultural equipment.

The standard for organizing effective work is the use of electronic catalogs of spare parts, electronic manuals, and the organization of communications with dealer companies. The collection of data on the condition of the machine, its performance is also organized and sent either to a specialized company program (Komatsu, John Deere) or to the ERP system used by the enterprise (Ponsse). A further development of John Deere electronic systems is the organization of remote access to the machine and its remote diagnostics using the JDLink system (Figure 2) with storage of information about the machine on the manufacturer’s server and organization of access to it for the owner and dealer planning technical maintenance and repair of equipment.

When organizing servicing of equipment, it is necessary to take into account that the operating conditions of agricultural and logging equipment are different in terms of the possibility of organizing continuous communication between the machine and the manufacturer’s server due to the fact that agricultural equipment operates in an area with a good level of mobile communication signal, while logging machines operate far from populated areas points in the area of uncertain signal reception, so there is a need to use

information storage devices. The transfer of received information to the server can be carried out periodically (which reduces the efficiency of managing its work), or requires the use of repeaters or a satellite data transmission channel. In-creasing the efficiency of organizing the work of a group of logging and skidding machines at a cutting site can be achieved by creating temporary networks based on Wi-Fi modules [22]. To increase the accuracy of machine positioning, in this case, it is recommended to use digital sur-face model (DSM) visibility analysis [23], which allows increasing the autonomy of machine operation.

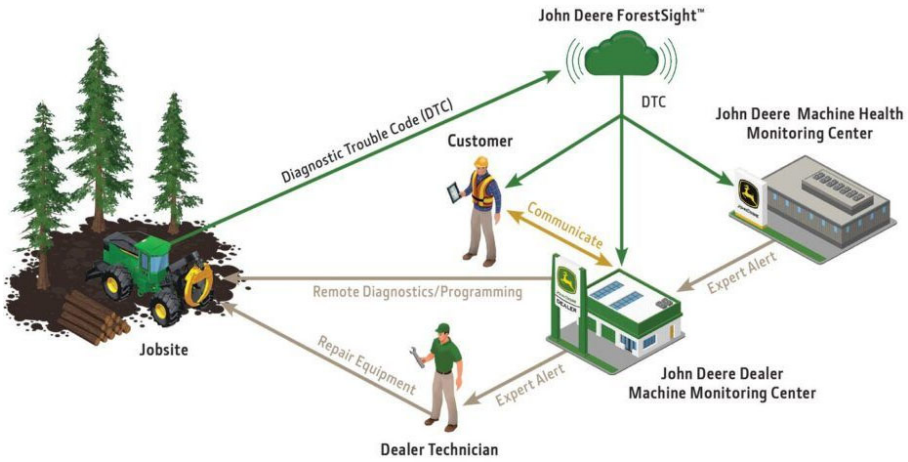

Fig. 2. Example of a John Deere machine diagnostic system

In the conditions of enterprises using equipment from different manufacturers, it is advisable to use machine maintenance and repair management systems developed by independent manufacturers, which can be divided into 5 classes (Figure 3).

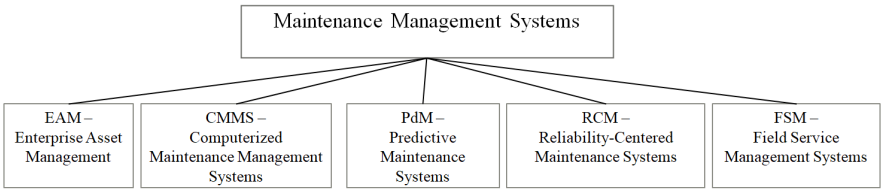

Fig. 3. Maintenance and repair management systems

When choosing a specific management information system, you should take into account functions belonging to several classes; it is also advisable to take into account the possibility of integrating into a unified enterprise management system of the ERP class, such as domestic ones: 1C (1C:TOIR, 1C:RCM Reliability Management), Galaktika (Galaktika EAM), and foreign: IBM (IBM Maximo), SAP (SAP Predictive Maintenance and Service, SAP Asset Intelligence Network), Oracle (Oracle Enterprise Asset Management) [24]. When using forestry equipment, it is important to provide for the possibility of relaying transmitted data to the company server on a continuous or periodic basis. Thus, the problem of increasing the efficiency of machine maintenance and reducing the cost of maintaining their good condition is relevant and can be solved through digitalization of processes based on software solutions from both manufacturers of agricultural and forestry machines, and through the development of third-party companies.

4 Conclusion

Based on the research, it has been established that much attention is paid to improving the maintenance of machines. Digital services are actively developing, aimed at automating the pro-cess of monitoring the condition of machines and managing their service, both by dealerships and developed software products from third-party companies, while the presented software is ofered by both domestic and foreign companies. The most advanced software products are aimed not just at streamlining the management of maintenance and repair, but at increasing the performance of machines and equipment through constant monitoring and predicting changes in the parameters of controlled units and systems. The choice of a specific software product should be based on an analysis of the enterprise's requirements and compatibility with existing ERP enter-prise management systems.

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