Improving the efficiency of diagnostics and repair of ICE and road construction machinery in ISTK

To cite this article: D Stepanov et al 2020 IOP Conf. Ser.: Mater. Sci. Eng. 832 012016

View the article online for updates and enhancements.
Improving the efficiency of diagnostics and repair of ICE and road construction machinery in ISTK

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Abstract. This article contains analysis of possible ways to improve the efficiency of diagnostics and repair of internal combustion engines using information systems. Common repair methods for these machines are reviewed here. The analysis revealed disadvantages, which increase, time and cost of repairs. The lack of computerized workplaces reduces the productivity of engine repair department. As a solution to this problem, it was proposed to equip the mechanics’ workplace of the ICE service department with a computerized widescreen LCD panel and a tablet with preinstalled software. This system allows to control the work process in real time. The system increases the productivity of the service department, reduces costs and time for diagnostics and repairs. The system also allows to analyze the possibility of reusing spare parts.

Keywords: automation, repair efficiency, diagnostics, internal combustion engines.

1. Introduction

Komatsu Technical Support Service Center in Obukhovo, Moscow Region, is the largest Komatsu service center in the Central Federal District. The center provides quality repair and maintenance services of Komatsu construction machinery. Nowadays the company is able to perform all main types of regular repairs and overhaul of any road construction machinery manufactured by Komatsu. These are bulldozers, excavators, articulated dump trucks, pipe layers, wheel loaders, backhoe loaders.

In order to increase the efficiency of repair tasks, a work automation system was developed in cooperation with the manufacturer to correct existing disadvantages and solve current problems.

The aims of automation are to increase the efficiency of repairs and to make repair process more transparent. The system designed to reduce the number of mistakes and dependence on the human factor, to accelerate service related tasks, and reduce repair costs. This system not only boosts productivity, but also improves control over the repairs process. It also provides online monitoring of the overall repair time, time spent per each process stage (for example, time from the ICE arrives to department to the moment when ICE is assembled). These features helps to control the service duration standards and evaluate the work quality of employees and the entire service department. Only availability of objective information can help to identify current problems and suggest the right solutions.
2. Problem description
Before the whole system was integrated in service process, we had an examination of the existing service system. Time of work, efficiency and productivity of the service department, repair mechanics surveys were analyzed. As a result, we revealed a number of existing problems.

For example, when repairing engines and transmissions of road-building machinery, the traditional methods was used: the mechanic had only paper instructions with entire step-by-step disassembling algorithm, with tables indicating nominal dimensions of parts, i.e. piston diameter, cartridge diameter, crankshaft position and other data, as well as techniques to determine defects in machine parts. The papers got dirty and quickly became unusable. Moreover, these manuals are usually made in black and white, which makes it difficult for interpretation, and the information becomes outdated in terms of constant upgrades and modifications.

The entire data obtained during the measurement was processed manually. Analysis of the spare parts reuse possibility during troubleshooting was not even included in mechanics tasks. Moreover, the old system was unable to eliminate human-factored faults. Customers also experienced some inconvenience when making a decision. Diagnostic results were provided in tables which needs additional interpretation.

Changes to the existing method will:
1) Improve repair times.
2) Increase the transparency of repair (the system will make it possible to control speed standards, evaluate work quality, and make problem-solving decisions).
3) Make it able to control the amount of data (the system has an easy understandable reports of the results of troubleshooting).
4) Coordinate actions (simplified mechanic-manager-client-warehouse interaction).
5) Improve service effectiveness.
6) Reduce staff training time.
7) Reduce human-factored problems (step-by-step manuals with color pictures and guidelines minimizes the risks of mistakes).

3. Features of the integrated automated engine repair and diagnostics system.
We started to search for new solutions while trying to make these improvements possible. Together with Komatsu CIS, we implemented the control system for engines and transmissions disassembling and troubleshooting in the Obukhovo Technical Center. The system involves the following mechanics work layout:

As part of the program implementation, the service department was upgraded. The mechanic’s workplace was computerized and equipped with a widescreen LCD panel, which greatly improves the work with digital materials. A tablet is integrated into the system, with preinstalled software which allows to control the work process in real time by registering all the data in the system.
Interaction with information system built on technological processes, which can be divided into stages. Disassembly is one of the first stages. The intuitive interface of the program allows the mechanic to get started without longtime training. To start working the system requests the input of basic repair data, the name of the mechanic conducting the repair, the place of the repair, as well as all the necessary information on the unit to be disassembled.

After entering the main data, a menu window pops up. Measurement values needs to be entered in the working window, and this window shows data on:

- Possibility of spare parts reusing.
- Spare parts to be disposed of.
- Spare parts to be replaced.

The software will also indicate the parts that need to be removed to ease the disassembly process. If defective parts are found, the software allows to add a picture on which you can mark additional information.

Modern interface and color indication highlight each category of spare parts with its own color, e.g. white – the spare part may be reused, yellow – the spare part needs mechanical processing, green – the part must be replaced, black – the part must be examined carefully, red – pause or delay the process, blue – detailed disassembling of the unit is needed (e.g., water pump).

| Reason for replacement | Not to be reused | Missing | Worn |
|------------------------|-----------------|--------|------|
| Damaged                | Disrupted       | Upgrade|
| Age replacement        | Fails the specification | ------|
|                        | ------          | ------|
|                        | ------          | ------|
|                        | ------          | ------|
|                        | ------          | ------|
|                        | ------          | ------|
|                        | ------          | ------|
|                        | ------          | ------|
|                        | ------          | ------|

**Figure 2.** Upgraded mechanic’s workplace

**Figure 3.** System interface menu
After the disassembly and troubleshooting are completed, the software offers to arrange the parts for repair, analyzes location, replacement possibility and timing of the earliest delivery. There are several key stages in the process of parts arrangement. Firstly, generating of the parts selection plan, then selecting parts (the system provides all necessary information i.e. part name and index, quantity of parts, pictures of parts, and which parts are missing.

![Spare parts catalog of built-in the system interface](image)

Figure 4. Spare parts catalog of built-in the system interface

After all the spare parts arrived at the warehouse and are received by a mechanic, the software proceeds to the next stage – assembling.

The assembly process starts with generation of a process plan which considers various details i.e. start date, expected repair completion date, model of the unit, unit catalog number, unit serial number, machinery model, type of work, work order number, branch office code/number, and the customer name.

During the assembly, the software indicates not only the installation location, but also the tightening torques of mounting bolts and nuts.

After installing and checking each spare part, the mechanic shall put his electronic signature. When the unit is assembled, all the necessary data is stored in the system. Data can be stored for an unlimited amount of time, and can be used to analyze information at any time.

Just two months have passed since the implementation of the system, however it has definitely increased labor efficiency and productivity.

For example, when repairing the Komatsu SAA12V140E-3 engine (12 cylinders, 301, 976 hp, 4-stroke, water-cooled, V-shaped, with direct injection, turbocharged), the repair time was significantly reduced with the quality maintained.
Figure 5. Standard benchmarks for engine assembly

Graph 1. Comparison of time spent on repairs, standard vs upgraded methods.

So, the total hours spent using the standard method is 354 working hours, and using the automated system – 328 working hours, which makes a difference of 26 working hours. This difference reduces repair time, equipment downtime, and also allows to set more competitive repair prices.

We invite you to our Obukhovo Technical Center, where you can find out more about the new system, and its advantages and features.

4. Conclusion
The software is currently under testing and adaptation process. However, even now we may indicate the advantages i.e. operation ease, availability of up-to-date disassembly instructions, spare parts catalog integrated and constantly updated, step-by-step assembly process and repair quality control. The system also provides great opportunities for optimizing the work cycle by analyzing the problems that occurs during the work and suggesting quick solutions.
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