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LEAN PRINCIPALS AND RFID USAGE FOR IMPROVEMENT OF DISASSEMBLY EFFICIENCY

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Abstract. *The efficiency of the system for disassembly is constantly open question. There are many problems, and their elimination can significantly increase efficiency of these systems. The paper proposes the application of LEAN principles and Radio Frequency Identification Technology (RFID) with supporting Product Life Administration - software solution (PLA), for the identification and analysis of problems which need to be overcome, in an effort to increase the efficiency of production systems for the disassembly of the product.*
Key words: *RFID, LEAN, disassembly, efficiency.*

1. INTRODUCTION

Disassembly is defined as the process of dismantling of the product into its constituent parts or subassemblies [1]. It also includes the analysis of product's state and selection of separate parts. It is a set of operations that are performed on the work stations for disassembly with the help of specific tools.

To effectively carry out a disassembly process, technological process of disassembly was established after the complete determination of influential factors on disassembly. Influential factors in disassembly are [1]:

- materials and parts (hazardous materials, valuable - expensive materials, re-usable parts),
- structure and connections (type of parts, number of parts, the connection method),
- disassembly method (non-destructive, partial destruction, destruction),
- costs of disassembly (disassembling time, disassembly location),
- the state of the disassembled parts (purity, erosion regard, the level of quality for recycled parts),
- disassembly technological process data (quantity, existing disassembly system, cost effectiveness),
- used technologies (regeneration techniques, depositing methods, re-use, cost of reprocessing),
- disassembly equipment (machines for disassembly, disassembly tools, disassembly accessories),
- disassembly technological process, and
- disassembly process (the content of the operation, the direction of disassembling, disassembly forces, tips).

All the assumptions for the effective execution of the disassembly process are basically appropriate informations. Their ensuring is necessary in order to achieve a balance between efficient use of labor, tools, machinery and space. Systems for disassembly can have various configurations, complexity and size. Major contribution to the success when designing large and complex disassembly system is achievement of economic goals and efficient use of resources, which is achieved basically by reducing the effects of the eight losses according to LEAN philosophy [2].

To achieve these objectives, in the paper will be presented the results of research into the possibility of applying RFID technology as a support to collect the necessary information with the use of appropriate software solutions - PLA (Product Life Administration - software for product lifecycle information processing) and User Interface - RFID (UI - RFID) as well as his part for the implementation of the system for disassembly. In addition, the use of RFID technology is suggested and as a support for effort to apply the basic principles of LEAN philosophy.

Basic elements of each RFID system are [4]:

- tag - as a carrier of information, represents a mandatory component,

- reader - also a mandatory component,
- antenna (required),
- controller - mandatory component, but most readers of new generation has this component built,
- sensor, indicator and actuator – These optional components are needed for external input and output of system, and
- software support.

2.1 The software structure for application of the RFID

Software for processing information from the product life cycle consists of two parts.

The first part is a central part, and it is used for the processing of information in both directions - to users and receiving information from the user. This software is PLA software (Product Life Administration - Information processing software during product life cycle).

The second part of the software is planned for communication with users and is called User Interface - RFID (UI - RFID) (Fig.4.). UI-RFID also processes information in both directions, but the information that UI-RFID forwarded to the PLA is shorter.

2.2 User program in disassembly - UI-RFID-D

Products that come in disassembly system do not carry any information about their lifetime who have just finished, and on the other hand there is no information either about the structure of the product - parts and materials. For this reason, the process of the product disassembly is substantially hampered due to lack of knowledge about: the disassembly process, condition of each component and the type of material which has the effect of reducing the quality of selection of the disassembled components and materials in the appropriate flows [1].

Therefore, the application of RFID technology can significantly help overcome the problem.

UI-RFID-D software was developed to help overcome the problem of information lack, and also to enable the optimization of product management, materials and its individual components.

The user interface in the disassembly (UI-RFID-D) aims to provide information on the procedure for product disassembly, the necessary tools and selection of components on the one hand, and on the other hand, that the manufacturer receives information about the status of a product that has arrived in the disassembly system (Fig. 4.).

It is this segment which creates a better perspective of the possibilities for product management throughout the life [4].

3. BASIC LEAN PRINCIPALS

LEAN philosophy is basically based on five principles:

1. Value – focus on customers (the ability or the possibility to meet the requirements of customers with products and/or services at the right time and with the proper price);
2. Value stream – effective and efficient work processes of determining the needs and expectations of customers, and to their fulfillment;
3. Flow — continuous flow, so that the product passes all processes, without stopping, rejects, poor quality, etc;
4. Pull – start production at the request of customers;
5. Perfection – perfection in the work through continuous search for perfection.

Moving towards the fulfillment of these principles is a long way to go, and the model that is being proposed is simply a step in that direction.

3.1 Causes of lower disassembly process efficiency

Workplace losses are numerous and vary. Every type of losses on the work places could be recognized trough 7 basic wastes: Overproduction, Wait Time, Transportation, Overprocessing, Inventory, Motion, and Defects/Rejects [4], [5].

Each of 7 wastes affects the inefficiency of whole system and contributes to lack of productivity and employee safety. Some of basic causes of losses (wastes) of the system are [1]:

- Lack of information about the product,
- Lack of knowledge about the structure of the material,
- Lack of knowledge about special procedures
- Wrong selection of materials,
- Slowing down the process due to variable product selection, and
- Losses due to inappropriate movements during the operation.

The most common case with which is faced disassembly systems is the presence of different types of products that result in efficiency reduction of workers.

Figure 1. Numerous electrical and electronic products

This causes problem to the workers at the disassembly stations during operations, which consist list of sequences shown on figure 2.

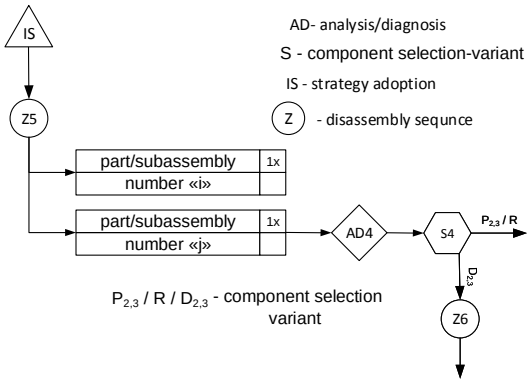

Figure 2. Disassembly standard procedure

For this reason, the process of the products removal due to lack of knowledge is significantly hampered, because of the lack of knowledge of technology for disassembly of products and regarding this, necessary tools, status of individual components and the type of material (which has the effect of reducing the quality of disassembled components and materials in the appropriate flows [4]).

Observing an individual work in the process of the product disassembly, it is very easy to identify individual losses according to LEAN definition (see 3.1). Figure 4 shows a usual situation with which workers are faced in the process of product disassembly.

Figure 3 shows usual situation with the presence a number of tools at the work stations. One of the reasons lies in the problem of the impossibility of planning the necessary tools for disassembly of products which arrive into the process.

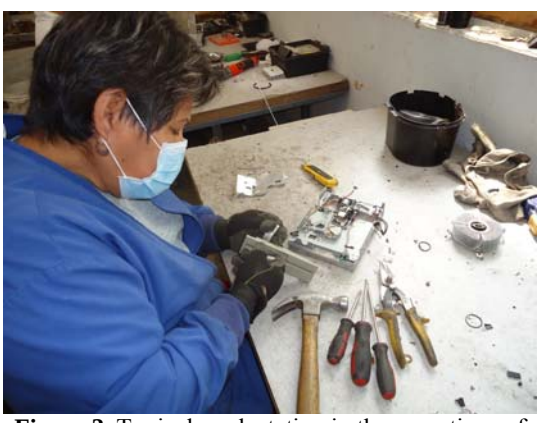

Figure 3. Typical work station in the operations of products disassembly

Hence, there is the need for supplying working places with a large number of tools.

Due to the presence of a large number of tools in the process, comes to the extension of required time for work, as a result of the search for the appropriate tools by the workers. "Crowd" of other tools required for disassembly of particular types of connection in the product complicates and slows down the process (eg. different dimensions tools for unscrewing).

Therefore, the application of RFID technology to a large extent can help to overcome the above problems by providing information which tools are needed and how an operation and selection of components should be performed.

4. APPLICATION UI-RFID-D IN THE SISTEM FOR DISASSEMBLY

UI-RFID-D software was developed to help to overcome the problem of lack of information and also to enable the optimization of product management, materials and its individual components.

Systems for disassembly of products have a problem that they need to process a large number of different varieties and types of products. For most of products, as already mentioned above, there is no any information on the procedure of disassembly and after that how to conduct separation of components and materials which are obtained through disassembly of products.

In addition, in most cases there is not even any information about the status of the manufacturer product in its life cycle. The user interface in the disassembly (UI-RFID-D), aims to provide information on the process of removing the product, the necessary tools and selection of components on the one hand, and on the other, to transmit the information to manufacturer about the status of products which has been received in the system for disassembly (Fig. 4.).

This segment creates a better perspective of the possibilities for product management throughout their life [4]. On the Figure 4 has been shown the principle of designing UI-RFID, and concept that only the most basic information should be distribute toward the work stations, which are needed to correctly execute working operations.

Also, the use of a software interface does not burden the process of work and activities of the worker are reduced to a minimum. Reading the tag in front of certain workers in the process, at the screen appears: marking the start of the operation (start time) (Figure 4), a request for a description of the technological process and the necessary tools-description (if necessary) and marking the end of the operation mode (end time). This allows rapid decision making in the process of disassembly, which has so far largely been the reason for the prolonged processing of certain products. Longer time of the product disassembly will directly affect the cost of processing the product [2]. Observing and analyzing processes of disassembly through use of data obtained by application of UI-RFID-D, could be monitored the performance of each work stations.

Analysis of this kind of data, could help to identify the problems and their causes, which has resulted in some of the above mentioned seven types of losses (3.1).

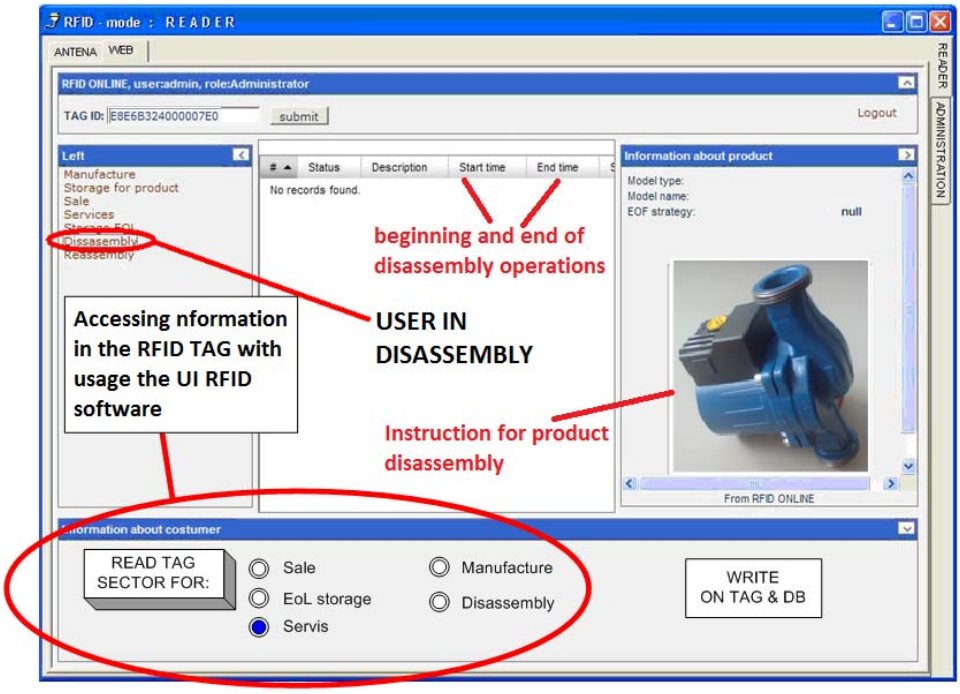

Figure 4. UI-RFID-D software interface

Application of such kind of solution is directly affected on the elimination of losses according to the LEAN philosophy; such are overprocessing, movement, wait time, defects/rejects.

4. CONCLUSIONS

First step in an attempt to increase the efficiency in operations of systems for disassembly should be sought in the solution or at least reducing the impact of the following problems:

- The question of the efficient tool selections,
- The question of availability of tools for disassembly (the availability of the selection is made)
- Availability of information's in the form of instructions on how to perform the product disassembly.

In other words, how to disassemble specific connection, on the product in the fastest possible way. For this purpose it is necessary to define, exactly on time, necessary tools, in the shortest time, which should be immediately available. Instructions on how to separate certain connection, with the selected tool should be equally available and clear in the description of how to perform a specific procedure of disassembly. The first step in that direction is to provide necessary information by using RFID technology and the corresponding software solutions. In this way, the race against time has begun. That is the first prerequisite for the implementation of LEAN principles, with the aim to increase the efficiency of the system for the disassembly of the products.

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