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Extending the lifetime of capital goods by tackling obsolescence of electronic assemblies

An innovative and cost-effective strategy

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***Abstract*— Obsolescence of electronic assemblies has become a significant problem especially in capital goods e.g. trains, planes, industrial facilities and commercial vehicles. Tackling obsolescence ensures an extended lifetime of these capital goods. Therefore, strategies for the after-series availability have to be developed. One possible solution is described in the obsolescence management application guide DIN EN 62402. Nevertheless, a consistent obsolescence management is indeed a very resource intense process and no practicable solution for small and medium sized enterprises (SME). Within the research project "Electronic after-series availability" an innovative and cost-effective strategy is developed.**

***Keywords*—obsolescence management, reverse engineering, remanufacturing, longtime storage proactive, reactive, electronic assemblies, after-series, availability**

I. Introduction

Electronic assemblies have an enormous influence on innovations of modern capital goods. For example, electronic assemblies drive about 60% of the innovations made in the automotive industry [1]. Another reason for an increasing use of electronic assemblies are the rising complexity and the individualization [1]. However not only the automotive sector does have an increasing use of electronic assemblies. There are capital goods of other industries, which are even more valuable and have longer lifecycles, e.g. trains, planes and industrial facilities. A comparison between the lifecycle of these capital goods and the implemented electronic assemblies shows a huge difference. Electronic assemblies often have a lifecycle about a few years, capital goods have a lifecycle about a few decades. This is a problem for the original equipment manufacturer (OEM) as well as the operator of these capital goods. Industries, which are especially affected by these problems, are shown in figure 1.

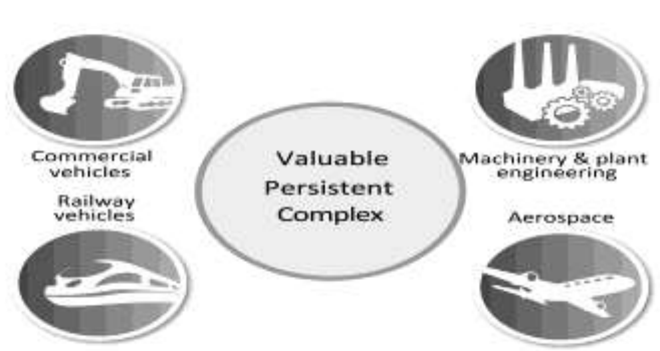

Figure 1. Industries which are especially affected by the obsolescence of electronic assemblies

If an electronic assembly is damaged after a few years it is often not possible to repair the assembly. That is because the electronic components, e.g. the microcontroller, which are implemented in the assembly are not available any more. Due to the fact that the technology cycles of such microcontroller are obvious shorter than the lifecycles of capital goods. Figure 2 shows this difference. In summary, this means the damage of one electronic assembly can lead to a shorter lifetime of the capital good they are installed.

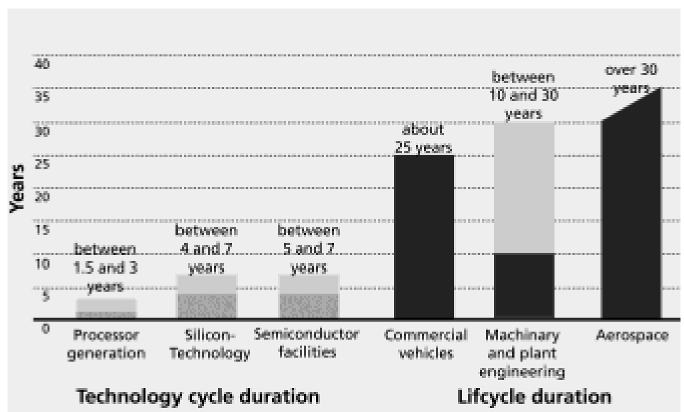

Figure 2. Difference between the technology cycles of electronic components and the lifecycles of capital goods

The described problem of electronic assemblies becoming not available any more is called obsolescence. Obsolescence according to a definition given in the DIN EN 62402 is the change from availability to non-availability or the permanent transition from functionality to non-functionality because of extern influences of a product. Obsolescence causes all products and has influences over the complete lifecycle of a product. Products in this context are capital goods, infrastructure, durable goods, consumables and software products [2].

Nevertheless, obsolescence can be handled or managed. The so called obsolescence management is part of a company`s risk management and is described for the OEM [2]. However, obsolescence management is a complex and expensive process. Big companies have separate divisions for handling obsolescence problems. Besides small and medium sized enterprises (SME) are affected by obsolescence problems too. The problem for SME is that they cannot afford a consistent obsolescence management. Therefore, a new strategy is developed within the research project "Electronic after-series availability". In addition, common solutions for the obsolescence problem are only for the OEM of a capital good. The new developed strategy could be applied from the operator of a capital good too.

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The structure of this paper is as follows: In the second section, we introduce common known issues of obsolescence management and its tools. After we discussed obsolescence management, we present the research project "Electronic after-series availability". In section three, we show the new strategy and give an example how to use it. In the last section, we discuss our results and give a short outlook to forward developments.

II. Methods

A. *Obsolescence management process*

The DIN EN 62402 includes an application guide for obsolescence management. The obsolescence management standard coordinates activities to direct and lead an organization regarding obsolescence. The described obsolescence management process is divided in three process steps and is shown in figure 3. The three process steps run parallel to the lifecycle of the regarded product.

The first step of the obsolescence management process is planning for obsolescence. This initial process step runs parallel to the definition step in the product lifecycle, see figure 3. An obsolescence management plan is developed within the product lifecycle management. The aim of this obsolescence management plan is to describe strategies to identify and reduce the impact of obsolescence. The major objective is to find a compromise between the total lifecycle costs on the one hand and the longtime availability of the product on the other hand. Therefore, two different kinds of strategies are available:

- A strategy is called proactive, if the probability of future obsolescence is minimized. The strategy is developed before obsolescence occurs. Proactive strategies are e.g. technology transparency, obsolescence monitoring, planed system upgrades and stockings.
- A strategy is called reactive, if a non-predictable obsolescence is occurred. The strategy is developed when obsolescence occurs. Reactive strategies are e.g. searching for products, dismantling, repair and design modifications.

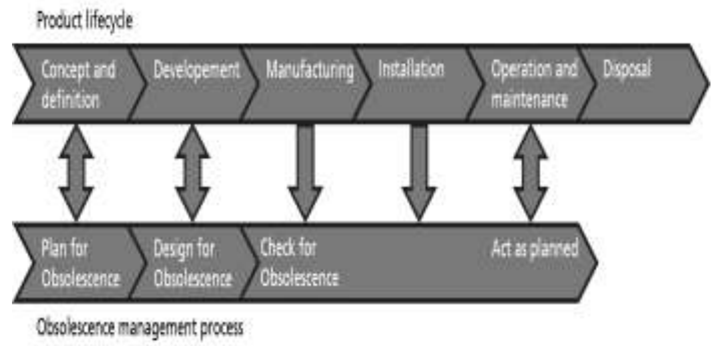

Figure 3. Product lifecycle and obsolescence management process [2]

The second step of the obsolescence management process is design for obsolescence. The aim of this step is to introduce proactive activities during the development process step in the product lifecycle, see figure 3.

The third step of the obsolescence management process is checking for obsolescence and acting as planned. This last process step runs parallel to the manufacturing, installation, operation and maintenance as well as disposal step in the product lifecycle, see figure 3. The aim is to execute the obsolescence management plan.

B. *Strategic obsolescence management*

Björn Bartels describes the obsolescence management process according to DIN EN 62402 as strategic obsolescence management including reactive, proactive and strategic elements [3]. He names six key methods of the strategic obsolescence management:

- Obsolescence management has already be considered during the part selection process
- Information sharing and standardization systems should be used as proactive elements
- Strategic methods to define, design, partition, acquire and use products should be developed
- All available resources for procurement of components should be identified and used
- The obsolescence management of products should be developed for whole systems not only for single parts and components
- Life cycle management should be implemented for products by planning the optimum mix of reactive mitigation and design refreshes

The introduced strategic obsolescence management process as well as the DIN EN 62402 are no practicable solutions for SME and for operators of capital goods. The reason for that is the amount of resources a company has to provide to implement or execute these solutions. Besides the described obsolescence management methods are general methods and no guideline to handle the obsolescence of electronic assemblies for capital goods.

C. Research project „Electronic after-series availability“

This was the initial situation to request the research project “Electronic after-series availability”. The research project started in the beginning of the year 2014. Project partners are nine SME, one big company and two research institutes. The management institution is the Fraunhofer Project Group Process Innovation. The aim of the research project is to develop new practicable solutions to handle the described problem of obsolescence of electronic assemblies. The developed solutions should be especially convenient for SME and operators of capital goods. Regarded sectors are aerospace, machinery and plant engineering, commercial vehicles and railway vehicles. These sectors have in common that their products are persistent, valuable and complex, see figure 1. All partners of the research project have different competences, like hard- and software development or manufacturing of electronic assemblies. The different sights of view help to develop a consistent and practicable strategy.

III. Results

A. Innovative strategy for handling the obsolescence problem

Within the research project “Electronic after-series-availability” a new strategy to handle obsolescence of electronic assemblies was developed. The major objective of this strategy is to deliver an after-series availability for capital goods with electronic assemblies. The strategy should be usable for SME as well as for operators of capital goods.

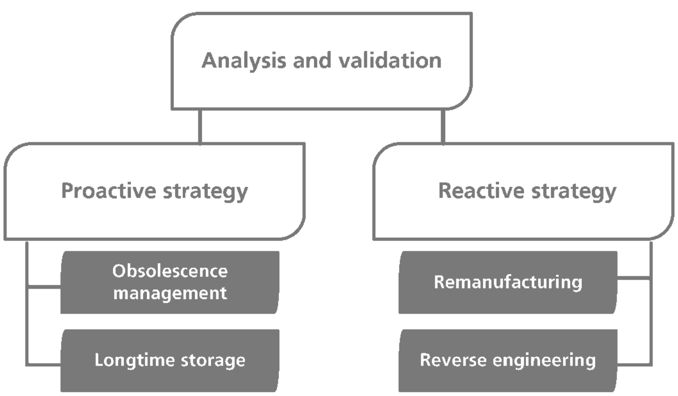

Figure 4. Developed strategy for handling the obsolescence problem of electronic assemblies

As an initial step an analysis and validation of the considered capital good is executed. Therefore, all electronic assemblies of the capital good have to be identified as well as their interfaces to other systems. After the identification of all installed electronic assemblies, every single electronic assembly has to be examined. According to the availability, complexity and number of the electronic assemblies the next step is chosen. Thinkable is a proactive strategy, a reactive strategy or a combination of both strategies to ensure the after-series availability of the considered electronic assembly. Figure 4 shows the developed strategy.

The proactive as well as the reactive strategy use two technologies. The proactive strategy uses the technologies long-time storage and obsolescence management. The reactive strategy uses remanufacturing and reverse engineering. In the following, these four technologies are described in detail.

a) Obsolescence management

Obsolescence management within the strategy of the research project “Electronic after-series availability” uses basic elements according to DIN EN 62402. Furthermore, forecasting methods and user software to detect discontinuance notifications are implemented. This technology is used if a high number of complex electronic assemblies is installed in the considered capital good because of the rising probability of occurring obsolescence.

b) Longtime storage

Longtime storage or longtime conservation is a technology to store an electronic assembly over a period up to 30 years. Therefore, the aging process of the electronic assembly is reduced by a factor of 12 until 15. This factor is reached by storing the electronic assembly under special conditions. [4]. The availability of sufficient new electronic assemblies is the precondition for using this technology.

c) Remanufacturing

Remanufacturing is defined as the process [5] to refurbish a used part on industrial scale. Precondition is the existence of sufficient old electronic assemblies in required quality and quantity. The remanufacturing process of electronic assemblies consists of six process steps: Initial test, dismantling, cleaning, testing single parts, refurbish and reassembly [6].

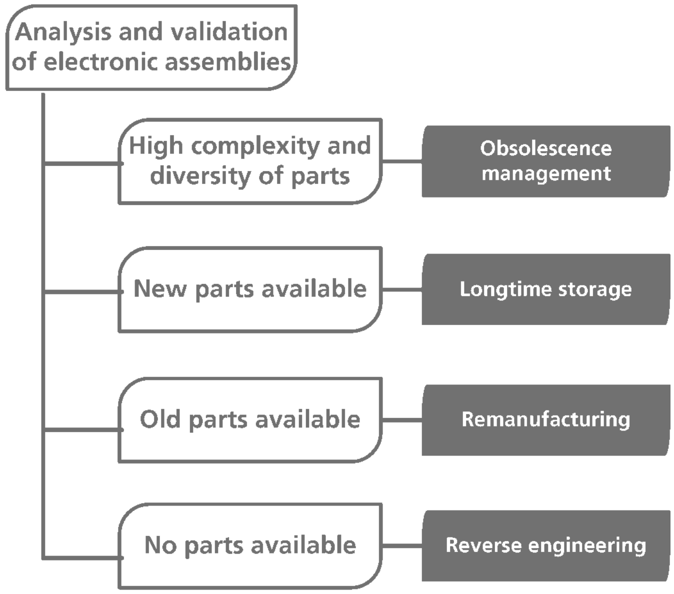

Figure 5. Technology decision diagram

d) Reverse engineering

Reverse engineering emulate and reproduce the functionalities of an electronic assembly. For this technology old development documents or if not available a black box model is needed. Reverse engineering is used if neither new nor old electronic assemblies exist in a sufficient quantity or quality.

B. *Technology decision diagram*

Figure 5 explains which technology should be used. The choice depends on the complexity and the availability of the original electronic assembly.

C. *Validation of the developed strategy*

The developed strategy was validated within an industrial project. The considered capital good was an automation system consisting of industrial robots. The after-series availability had to be ensured for a handheld terminal of an industrial robot. The analysis and valuation determined a reactive strategy. That is because of the limited availability of new handheld terminals of this kind. The reactive strategy consisted of remanufacturing because many old handheld terminals were available and most of the components could be reused. Nevertheless, single parts of the handheld terminal were meanwhile obsolete. Thus leaded to the reverse engineering technology. Using the developed strategy a guaranteed supply of the required handheld terminal was ensured. Besides its quality was also improved by upgrading within the reverse engineering. The refurbished handheld terminal is shown in figure 6.

Figure 6. Remanufactured handheld terminal for industrial robots

IV. Discussion

The introduced strategy helps SME and operators of capital goods to avoid the obsolescence of electronic assemblies. The strategy was applied in an industrial project. With the help of the developed strategy, it was possible to guarantee the electronic after-series availability of a handheld terminal for industrial robots.

In the next step a guideline for manufacturers and operators of capital goods will be developed. This guideline will base on the introduced strategy and will be independent from the OEM. This is a complete new approach because all existing solutions are for the OEM of the capital good. In addition tools will be developed for an effective implementation of the guideline. Possible tools are the RFID support or the implementation of the innovative wireless (service-) interface "Radio Frequency Communication" (RFCo) [7]. Fraunhofer also developed this interface.

V. Acknowledgment

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