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## Sources and characteristics of information about product use

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### Abstract

Knowledge about the activities happening beyond the point of sale is valuable for product and product-service design. In the product design community, the importance of this knowledge is accepted for several years, for instance through concepts like participatory design, as well as the living lab movement. An extensive involvement of users, in order to gain the desired knowledge, may prove time consuming and thus too expensive. Therefore, it appears expedient to utilize the existing information that is generated beyond the point of sale as effective as possible. In order to support research in this field, this paper provides an overview about different types of currently existing product information originating from the so-called middle of life phase. The overview is based on application cases that belong to different research and innovation projects, as well as practical examples from internet-based services. It briefly covers, for instance, data from embedded information devices, maintenance information, user-generated contents such as videos and product reviews. Within the subsequent discussion, some characteristics of middle of life information are highlighted. The characteristics are related to the different appearance of information and concern, e.g. differences among measured and articulated information, as well as the relation between instance- and class-based product information.

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### 1. Introduction

Traditionally, manufacturers of tangible products have very limited information about their products once they are sold to the end customer. In Product Lifecycle Management (PLM), the point of sale is the moment a product enters the middle of life (MOL) [1]. While the product is in its MOL, it is used in various contexts, maintained, repaired and different other value-adding services are applied as needed by the user. Due to these activities, the MOL is sometimes stated as the product's usage phase or use phase. According to [2], the MOL ends once "[...] a product no longer satisfies its user [...]". Strategies like product reuse by another user, as well as special use situations like multiple or anonymous users are intentionally omitted in this paper for reasons of complexity.

Information from the product usage phase is valuable for the product design. From this information, new knowledge can be concluded that can be beneficially applied in new product development [3] and product improvement [4]. The importance of this knowledge is recognized in the design community for several years, for instance in participatory design and the living

lab movement [5]. Participatory design approaches are based on the extensive involvement of users in design decisions.

The extensive involvement of users through techniques, such as structured interviews, moderated focus groups and experts' observations, may prove as an expensive approach for companies to gain information about the usage of a product. With respect to the cost of active user involvement, it can be suitable to work on information that is already available. This information may originate from maintenance activities and embedded sensor devices, as well as from the internet in the form of user-created contents.

Since there is no common definition for what the information from the MOL phase exactly is, a working-definition is suggested in this paper. The working definition is influenced by a similar definition of the term "field data" in [6]. With respect to the domain of PLM, a product's middle of life information is any product-related information that is created after the product is sold to the end customer and before the product is no longer useful for a user.

The paper aims to provide an overview about different types of MOL information, in order to substantiate future research and discussions concerning the MOL phase and the effective

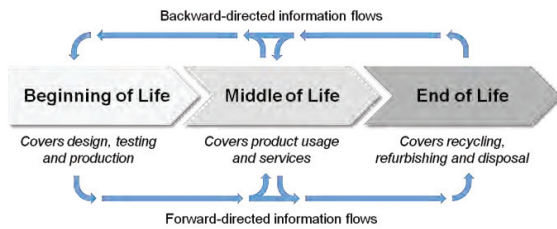


Figure 1: Phases and information flows of the product lifecycle

application of MOL information in beginning of life phase. Therefore, it doesn't cover PLM activities like product design (e.g. participatory design) and testing even though these activities might benefit from MOL information.

For this purpose, the remainder of the paper will be structured as follows: Section 2 will introduce the context of this paper, i.e. closed-loop PLM. It will further clarify the role of the MOL phase and provide examples of existing work concerning MOL information. Section 3 will briefly introduce the selected approach for this paper and is followed by the overview about the types of MOL information in Section 4. Based on this overview, there will be a discussion of the different types in Section 5. The paper closes with a conclusion and outlook listing future research tasks.

## 2. Related work

The first part of this section summarizes the current understanding of PLM. It further clarifies the meaning of the MOL phase with respect to PLM. In the second part, existing work about product use information is briefly presented.

### 2.1. Product Lifecycle Management

The process of handling product data and information across a product's lifecycle is termed *PLM* [1]. The product lifecycle can be structured into three subsequent phases stated as beginning-, middle- and end of life. Within the EU-funded large-scale research project PROMISE, the concept of PLM was further extended to specifically demonstrate that information loops among different processes across the lifecycle can be reasonably closed [7]. This *closed-loop PLM* takes advantage of the improvements in ICT technology by sharing item-level data and information collected by product embedded information devices (PEID). With respect to the design of new products and the improvement of existing ones, information flowing into the beginning of life phase is most relevant. An illustration of the three lifecycle phases and related information loops is provided in Figure 1.

The *MOL phase* is typically described by the interplay of the actual usage activities and product-related services. Because the product's usage is a central aspect of the MOL, it is also referenced as the product's "usage" phase [8]. The actual use of the product results in consumption/wearing of the product over time. The degradation is compensated by maintenance, repair and overhaul (MRO) services. These services aim for the extension of the product's lifetime which is especially relevant

for expensive products like machinery. During the MOL, other value adding services can be conducted, such as insurance, financing, leasing, status monitoring and location tracking.

Due to the rapid developments in computer science and servitization in manufacturing industry, complex products such as vehicles, home appliance and mobile devices tend to be combinations of physical components, software and services that can be subsumed as product-service systems [9]. In order to respect this development, the provided content in this paper has to be seen in light of product-service systems. In case a specific (unique) tangible product is addressed, the term "product instance" will be used in this paper.

### 2.2. Existing work about MOL information in PLM

Within the field of PLM, several authors covered MOL information already. Common synonyms are field data and product use information.

Early work on MOL information and its feedback into product design is provided in Jun et al. [10]. The authors considered the following contents as relevant (non-comprehensive summary):

- Maintenance and failure information: e.g. ease of maintenance, reliability problems, maintenance date, critical component list and root causes.
- Technical customer support information: e.g. customer complaints, customer profiles and response.
- Usage environment information: usage condition (e.g. average humidity, internal/external temperature), user mission profile and usage time.

Another perspective is taken by Fathi and Holland that argue about subjective customer feedback and measurable information stated as "product use information" (PUI) [11]. The latter ones are considered as more objective. Examples for PUI of a manufacturing machine are:

- Sensor data of the product (i.e. machine)
- Environmental parameters
- Quality parameters of the produced item
- Failures and breakdowns
- Incidences of maintenance

Since the aforementioned work is focused on quantifiable information, user generated contents (e.g. user feedback) are not covered. User feedback, on the other hand, is covered in [12].

## 3. Approach

In order to identify types of MOL information, real applications are investigated in this paper. The applications are demonstrated in research and innovation (R&I) projects or exist as web-based services in the internet. Though MOL information is a term used in the context of PLM, other domains investigate very similar information from other perspectives. Examples for related domains are marketing (e.g. after-sales management), context-based system development (e.g. adaptive interfaces and personalized content), and service engineering. Since the paper argues from the perspective of PLM, the aforementioned domains are out of scope for this

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