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ScienceDirect

Procedia CIRP 60 (2017) 458 – 463

www.elsevier.com/locate/procedia

27th CIRP Design 2017

Technical change management for the maintenance of product platforms

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Abstract

In order to react to an increasing global competition on the one hand and an increasing demand for individual products on the other hand, product platforms became a well-established design concept for developing product families. By using the principle of modularization companies are able to achieve synergies within development and production and at the same time offer a wide variety of products. Therefore, approaches and methods for the initial setup of modular product architectures are well covered in the scientific literature. Nevertheless, a lack of research can be identified for the sustainable maintenance and continuous development of product platforms. Accordingly, most companies do not have a structured release management for the systematic introduction of technical changes and modified modules of physical products. In order to preserve the success of an implemented product platform, it is mandatory to plan the introduction of changes. In this paper, a new method is introduced for synchronizing the lifecycle of modules with the lifecycle of the respective platform products. The goal of this approach is to maximize the number of technical changes which can be implemented into products of an existing modular product platform at a certain time while minimizing development costs as well as changing efforts within production. At the end strategies are shown how to release physically changed modules into different product lines of a modular product platform.

Peer-review under responsibility of the scientific committee of the 27th CIRP Design Conference

Keywords: modular product platforms; lifecycle synchronisation; release strategies; technical change management; release management

1. Introduction

Nowadays, manufacturing companies are facing two major challenges concerning the development of new products [1]. On the one hand there are fast evolving technologies and decreasing product lifecycles, while on the other hand customers are expecting highly individualized products [2, 3]. Especially competitors from low wage countries force European companies to offer cost-efficient products with a high consideration of individual customer requirements [4, 5]. This leads to an increasing variety of external products as well as internal processes [5, 6]. One solution to handle this dilemma are product platforms [7]. They permit realizing economies of scale due to a repetition of modules or functions as well as economies of scope in terms of customer specific products [8]. As a study conducted by the WZL of RWTH Aachen University shows, many companies are already using a product platform and more than 40% of these companies are in a stage of advanced implementation [9]. Once a product platform is implemented it is not a static structure but a dynamic system which underlies changes in terms of upgrades or technical developments during the lifecycle[10]. Nevertheless, most companies do not follow a defined process to implement changes into an existing product platform [9]. So the question of handling technical changes is becoming more important. In context of release management detailed knowledge of change requests as well as relationships between physical modules have to be used for computing an optimal composition of new or changed modules which can be released at a certain point. Thus, this paper introduces a new method for synchronizing the lifecycle of modules with the lifecycle of physical products which are based on a common modular product platform. Strategies are shown how to release changed modules into different product lines of a modular product platform.

Peer-review under responsibility of the scientific committee of the 27th CIRP Design Conference
doi:10.1016/j.procir.2017.01.025

2. Related Work

As it was outlined in the introduction, there is a strong demand for developing a method for systematically introducing technical changes in product platforms [11, 12]. Research approaches of this topic are published under the term of release engineering or release management [12].

According to BELENER, there are two different reasons why technical changes occur during the product platform's life cycle [13]. The first reason is a technical change due to an improvement of the platform. The second trigger of changing requests is an error which can be divided into two different sub categories. On the one hand a module was not defined correctly during the concept phase, while on the other hand a module was not designed according the specification sheet. AßMANN defines every change during the phase of development as an iteration [10]. Whereas technical changing requests after start of production are called updates.

After defining reasons for changing requests and different types of technical changes, there is still the need for their systematical introduction into existing product platforms. In information technology the term "release" is defined as the "collection of one or more new or changed configuration items deployed into the live environment as a result of one or more changes" [14]. A similar definition is used by STAHLKNECHT and HASENKAMP, who describe a release as a periodical revision, improvement or expansion of software [15]. Also defining standardized timing and prioritizing tools are part of the research in that field [16–18].

Using this understanding release management can be defined as the process of planning, timing and controlling releases in test as well as live environments [16]. Research in this field focuses on the optimal point of market entrance of new variants. Thereby is the conflict between time consuming testing and introducing products to the market as early as possible to realize advantages against competitors [19]. That is why it is crucial to determine the earliest date of release while considering technical maturity and benefit for the customer.

The approach developed by SCHUH aims at consolidating all technical changes into. Due to this synchronized realization, companies are able to organize and optimize their internal development and production processes. Furthermore, it can be used for a dynamic adoption of competition and market conditions [20]. Within the methodology technical changes are classified considering whether the chances are time sensitive, avoidable or necessary changes. For every cluster a specific process and timeline is defined. Criteria for evaluating changes are implementation costs, urgency and sustainability [21].

CARLSHAMRE defines requirements for a certain release and provides an automated algorithm which selects certain customer requirements that have to be fulfilled at a certain time. Furthermore, CARLSHAMRE considers the level of quality that should be realized. As many of this requirements are dependent on each other, the process of selection is a complex problem [17].

The recent approach by WRIGHT uses eight case studies for describing release processes in the software industry. After analyzing faults within these processes WRIGHT proposes four hypotheses for describing the essentials of successful release management [18].

Concluding it can be said that these approaches focus on releasing more than one product. Nevertheless, SCHUH, CARLSHAMRE and WRIGHT lack on considering lifecycles for single modules. While SCHUH and WRIGHT take interactions between modules into account, this aspect is missing in CARLSHAMRE's approach too. Also CARLSHAMRE as well as WRIGHT do not classify different types of changes. None of the approaches above considers different strategies for releasing technical changes in products. In conclusion, there is no method to determine a release strategy for technically changed modules of physical products which are based on a modular product platform taking the change efforts as well as the benefits into account. Such a methodology is needed as studies show that industry do not have established any processes for introducing technically changed physical modules into existing modular product platforms [9]. Furthermore LINDEMANN ET AL. showed that most technical changes are not time sensitive so that change requests can be bundled and released at an optimal date [22].

3. Technical change management for the maintenance of product platforms

To fill the gap of identified shortcomings a new method for the maintenance of modular product platforms will be introduced. This method contains three steps to synchronize the lifecycle of modules with the lifecycle of the respective platform products systematically. First, the flexibility of a module of the product architecture needs to be analysed. Next, efforts and benefits of changing requests need to be quantified, in order to identify the optimum bundle of changing requests. Last, a release strategy for the introduction of the changes needs to be chosen. Following, all steps will be explained using an industry case study. Therefore, a hydraulically released brake from an industry project will be analysed. The break consists of ten parts which are shown in figure 1.

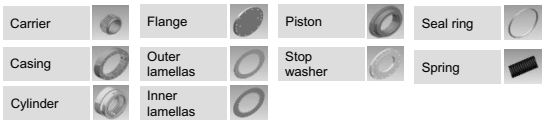

Fig. 1: Parts of hydraulically released brake (based on [23])

The proposed method is based on a systematic analysis of relationships between modules of a modular product platform. The central part is the identification optimal bundle of technical changes which is an optimization problem. This is solved by algorithms for a knapsack problem with restricted capacities.

3.1. Flexibility of modules

First of all, it is essential to analyze the current state of the product structure for future planning and upcoming technical changes. Therefore, an onion peel model is used to visualize the overall flexibility of a module and its direct correlation to release frequencies. For an objective and quantitative