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Identified adjustability dimensions when generating a product specific requirements specification by requirements reuse

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ABSTRACT

A requirements reuse setups typically includes reusable requirement set(s) containing a collection of reusable requirements and a number of product specific requirements sets which are drawn from the reusable set(s). The ideal scenario when reusing requirements is that all the product requirements can be drawn directly from the reusable set. However, this is rarely the case in product development as new requirements are likely to surface. A critical issue in requirements reuse therefore becomes how to enable products to efficiently reuse requirements as well incorporating changes to the product set. In this paper the objective is not to present a specific method for requirements reuse but to introduce and discuss the possible dimensions of adjustability when generating a product requirement set by reusing requirements from a reusable set. Six adjustability dimensions have been identified. An extensive state of the art is included to introduce the presented methods related to each adjustability dimensions. The options for implementing each adjustability dimensions in a requirement reuse approach are illustrated along with a discussion regarding the benefits and issues resulting from each option. This discussion should help practitioners to better understand the possible methods that can be implemented and to design a user friendly and sustainable approach. A case study, describing how the dimensions are incorporated in two requirements reuse approaches, for Danfoss Solar Inverters (SI) and Danfoss Frequency Drives is provided. As a result an overview of how each adjustability dimensions is implemented in each case is presented. The case study demonstrates that all the identified adjustability dimensions were important elements in requirements reuse implementation. The case study furthermore highlights the need, not only to understand the effects of each adjustability dimension but also of the dependencies to case specific criterions. The classification of adjustability dimensions in requirements reuse and the options for their implementation has not been outlined by previous research and should be a useful contribution both to researchers and practitioners working in the field of requirements reuse.

1. Introduction

Industrial product development is under increasing pressure to perform better in terms of efficiency, high-quality and high value output [1]. New product success or failure is strongly related to effective use of market information [2] and economy of scope for gaining a competitive edge [3]. One approach to improve engineering design and achieving fast time-to-market is through reusing previous knowledge when creating products that share characteristics with previously developed systems [1,4]. Because the work products have already been created, tested, and documented, productivity increases because consumers of reusable work products need to do less work [7]. Performing reuse at a certain level usually carries with it reuse at subsequent levels [6] therefore, higher the level of abstraction at which reuse takes place, the larger its benefits [8].

Requirements engineering emphasises on understanding the problem domain of a planned product, encourages the discovery of the true stakeholder needs and prevents premature solution selection. Poor requirements management has often been found to be one of the major causes for product failure in product

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development projects [5,7]. However, analysing and documenting requirements requires considerable effort and it might therefore be tempting to cut corners in this activity. Reusing requirements is beneficial in terms of improving quality, development productivity and time to market [5,8,9]. Requirements reuse has been pointed out as one of the most pressing needs and grand challenges in Requirements Engineering [6,10].

A requirements reuse setups typically includes reusable requirement set(s) containing a collection of reusable requirements and a number of product specific requirements sets which are drawn from the reusable set(s). The ideal scenario when generating a new product requirement set is that all customer requirements can be satisfied by exploiting existing assets and their variability [11]. The more realistic scenario, however, is that new and unpredicted requirements will surface [12]. The critical issue in requirements reuse therefore becomes how to enable products to efficiently reuse requirements as well as capturing product specific characteristics. In this context the adjustments that can be made when generating a product specific requirement set are an important issue. A number of contributions have been dedicated to the task of building a reusable requirement set but only a few publications specifically deal with the task of generating a product requirement set [8]. Several approaches presenting defined methods for requirements reuse management have been provided such as MARM [8], PRS [13] and SIREN [9]. These approaches differentiate greatly in their implementation for working with reusable information in the product set. A generic overview of the possibilities available for adjusting the reusable requirement set to the product set is missing. In requirements reuse there is no "one size fits all" and the most appropriate solution depends on the characteristics of the product domain and the organization developing it.

In this paper the objective is not to present a specific method for requirements reuse but rather to give an overview of the dimensions of adjustability that can be incorporated in requirement reuse approaches and to provide a discussion on each dimension. An extensive state of the art is included to introduce the presented methods that can be applied in relation to the each adjustability dimensions. The identified adjustability dimensions are present in all requirements reuse approaches and it is important to consider each dimension when designing a requirements reuse approach. Having this overview should provide practitioners with a better knowledge platform for creating an optimal requirements reuse approach that best fits their needs. This will also provide better defined criterions to evaluate the most suitable requirement tool support, since the tool support needs to be aligned with the types of adjustability that shall be supported when generating a product set. This paper is relevant for every organization that wants to incorporate requirements reuse and might be relevant for requirement tool providers as well.

The paper begins by identifying the adjustability dimensions that are the subject of this paper. Section 3 summarizes what methods have been suggested by previous research related to each dimension. In Section 4, the options for incorporating each adjustability dimension are presented and elaborated on. A case study, describing how the dimensions are incorporated in two requirements reuse approaches, for Danfoss Solar Inverters (SI) and Danfoss Frequency Drives, is presented in Section 5. Results are illustrated in Section 6, followed with discussions in Section 7 and finally the paper is concluded in Section 8.

2. Dimensions of adjustability in requirements reuse

This paper is based on the assumption that when generating a product requirement set there are a definite number of ways that it is possible to incorporate adjustments. This section gives an introduction of the identified dimensions of adjustability in requirements reuse, when generating a new product set. The adjustability dimensions are identified by taking a look at the elements existing in a setup of text based requirement sets. The elements are classified into three levels of abstraction.

- *Requirement set structure*: In requirements reuse the objective is to manage a number of specification sets, some containing reusable information and some contain project specific information. These could be repositories in a database or configuration tool, or they could be documents using Microsoft Word etc.
- *Requirement structure*: Within a requirement set there will be an approach to group and structure the requirements items. The requirements items are thus given a contextual relationship and order.
- *Requirements items*: The requirements items specify individual requirements information. The requirements can be split into two parts; the text field documenting the requirement and attributes and knowledge fields giving the requirement further identification.

Based on this classification, the possible adjustability dimensions are identified. They are the following:

1. *Constructing the requirements sets*; the reusable and product specific sets can be organized using different setup mechanisms. E.g. is it allowed to reuse requirements from one or more reusable sets?
2. *Changing the requirements structure*; is it allowed to change the structuring logic or move requirements around in the requirements structure?
3. *Free selection and combination of requirements*; it allowed to select any combination of requirements or is the selection constrained somehow?
4. *Adding new requirements*; is it allowed to add new requirements when generating a product requirement set?
5. *Changing attributes*; is it allowed to change requirement attributes when generating a product requirement set?
6. *Changing content of requirements*; is it allowed to moderate the content of the requirement when generating a product requirement set?

An overview of the abstraction levels and identified adjustability dimensions for each level is shown in Fig. 1.

This is an introduction to the identified adjustability dimensions that will be the subject of this paper. Section 5 will contribute to the existing theory by identifying the different implementation options available for each adjustability dimensions and by elaborating on the effects of which option is taken when designing a requirement reuse approach. First the adjustability dimensions will be analyzed by discovering what previous research has written about the dimension. We will look for which suggestions have been provided for implementing each adjustability dimension. This provides a non-existing overview, summarizing the existing approaches from the viewpoint of adjustability dimensions.

3. State of the art

This section will provide an overview of how each of the identified adjustability dimensions has been addressed by theory, in the order they appear in, in Section 2.

3.1. Constructing the requirement set

Different approaches can be selected for how to construct or organize the reusable and product specific requirements sets. If