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Getting Requirements Fit for Purpose - Improvement of Requirement Quality for Requirement Standardization

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Abstract

Designers formulate requirements to ensure development processes that anticipate stakeholder needs. Most development projects fail due to vague and imprecisely formulated requirements, which is linked to poor requirement quality in the early phases of development projects.
This paper presents the newly developed REQ Method to systematically support designers during the formulation of requirements, according to important quality criteria. The paper offers a critically reflected assessment scheme for documented requirements to assess requirement quality. The methodological support builds a valuable base for better requirement quality, reducing the risk of trade-offs and project termination.

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Keywords: requirements; requirement quality; quality criteria; methodological support; standardized requirements

1. Introduction

1.1. Motivation

Requirements arise from many different sources during the development of technical products. They are acquired by documenting the interests and expectations of stakeholders or by using process modelling and information from use processes for developing a technical product that delivers greatest stakeholder value [10]. Special focus is on the potential of manufacturing technologies and value creation during use which should be systematically integrated into the early stages of development processes (Figure 1).

Full potential is tapped if function-required properties are mapped to manufacturing-induced properties by property-mapping at an early stage of the development process [3,14] to tap full potential for product and process innovation that is induced by manufacturing technologies. This reduces the number of iterations during development [14], leading to reduced process time and improved product and process maturity. However, the aim of requirements is the determination of product properties and process variables in that the technical product is the operand or the operator.

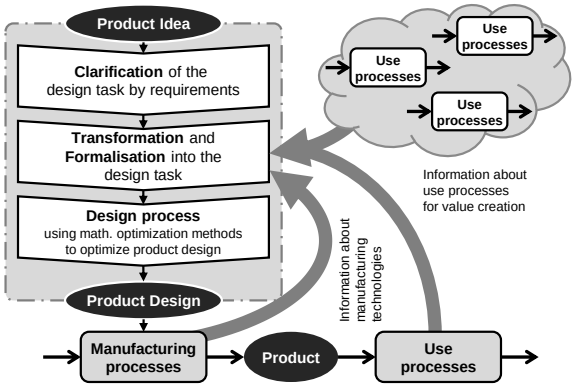

Fig. 1. Requirements within the manufacturing integrated product design approach, as enhancement to [4]

Based on desired properties, sets of product properties are determined, whereas desired properties of previous development steps are realized by the determined product properties. Designers should mainly focus on the content of requirements without thinking of standardized conceptual

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systems that simplify the identification of relevant design parameters for mathematical optimization.

Desired properties are important in the algorithm-based development of technical products and processes: they depict just one small area of the possible value range permitted by requirements by considering their specific links [3]. They help to structure the design task as only desired properties form the core of the solution. They only consist of the most relevant properties that should be realized in the technical product and function as a filter for the identification of design parameters for mathematical optimization.

The separation of requirements and desired properties is not only logical but pragmatic when developing technical products and processes using mathematical optimization methods for optimization of product geometry. Desired properties are included within the formalized product and process design task. Even if technical products fulfill all other requirements, the product itself cannot be used as demanded when desired properties are not fulfilled by the technical product. This leads to customer/stakeholder dissatisfaction since they do not perceive the value in the product.

1.2. Benefits of assessing the quality of requirements

Collaborative Research Center 666 - Integral Sheet Metal Design of Higher Order Bifurcations focuses on an algorithm-based product and process development process, using mathematical optimization methods that lead to optimized product geometry. The mathematically supported integrated product and process development approach demands a high level of requirement formalization to systematically identify relevant design parameters that function as input for the target function within the mathematical optimization methods used. However, conventional product development processes need not have highly formalized requirements. In contrast to algorithm-based product and process development processes, purposefully and intuitively documented requirements suffice, since conventional product development processes are geared towards comprehensive clarification of the design task within the project definition process [14].

Therefore, this paper focuses on an efficient formulation of requirements according to quality criteria to ensure a high level of compliance with the formalization of desired properties [9]. This formalization supports the systematic identification of desired properties in the design task, which is specified by requirements and affects the intended function of the technical product [9]. Early assessment and continual improvement of requirements during requirement acquisition or documentation in the requirement lists allows better determination of product properties.

This process may be supported by the REQ (requirement quality) Method. Similar approaches can be found in software engineering that ensure a standardized requirement formulation to systematically select appropriate design elements [12]. Major elements of these methods can be used in product development to guarantee a systematic consideration of requirements during product concretization, providing methodological support to algorithm-supported product development approaches.

2. The separation of requirements on and properties of a technical system

Value-driven development fulfills stakeholder needs, desires and expectations of a technical product. Unfortunately, most requirements are not documented to reflect the consequences of decision making during the development process [5,7], which directly influences product properties [14].

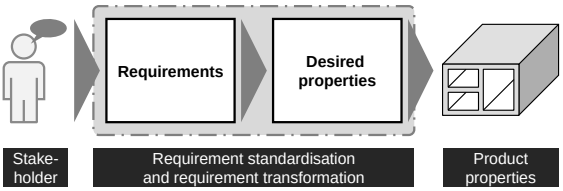

Fig. 2. Relation between needs and expectations of stakeholders, requirements and product properties

Although the formulation of requirements is wide in scope [10], it has to be done purposefully to systematically determine product properties during gradual concretization of the technical product (Figure 2). According to design science literature, requirements have to fulfill a large number of quality criteria to be well-defined [8]. However, a well-defined requirement is subjectively evaluated by designers in documented form within the requirement list.

Differentiation of requirements, desired properties and product properties is especially relevant during algorithm-based product and process development processes. Whereas requirements have high fuzziness in their formalism and documented content, only describing technical products that need to be developed hypothetically, product properties characterize the realized technical product in a highly formalized manner [2]. The variation in formulation of requirements, product properties and desired properties is mainly caused by the hypothetical character of requirements [2]. Product properties have to be continually adapted to underlying requirements to meet the requirements. The continual mapping between “what we want to achieve” and “how we want to achieve it” must be considered [13].

Since most decisions and designs are made using models that are purposefully abstracted to the essential components to develop technical systems [1], product properties from the basis for a property-based description of the technical product, according to its degree of concretization, and have to be especially considered for the identification and determination of design parameters that have to be optimized using mathematical optimization methods. This can be traced back to the fact that most product properties are not relevant to the development of technical products and processes.

The goal of every development process is to determine which product properties fulfill customer/stakeholder requirements best. Designers focus on processes that should be fulfilled to ensure greatest value for customer and user. They also have to focus on the technical product and its properties, since it operates during use and realizes the use processes [5] by providing appropriate effect values.