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Information management platform for the application of sustainable product development methods

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Abstract

A multitude of information is required to address sustainability aspects in product design decisions. However, information required for applying methods in the field of sustainable product development often overlaps. Moreover, specific improvement measures can primarily be identified if method results can be traced back to data origin. This paper presents a concept and implementation of an information platform which is integrated into a PLM system and integrates an ontology based knowledge model and a semantic wiki. The information platform shall avoid double work, improve documentation of information and assist in understanding the data basis of method results. This paper discusses requirements and solution elements and presents findings from applying the methods Lifecycle Design Strategies (LiDS) Wheel and the Product Sustainability Index.

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Keywords: Sustainable product development, information management, ontology, IT- tool

1. Introduction

Product development determines essential characteristics and properties of a product and sets boundary conditions for subsequent lifecycle phases such as manufacturing and product use [1]. During the last decades many methods were developed to identify or assess sustainability relevant properties. Applying different methods with often similar concepts but different concept naming implies a high risk of double work and a lacking comparability.

In the project Collaborative Research Center (CRC) 1026 “Sustainable Manufacturing” 50 methods were analyzed which address sustainable product development. Several potentials were identified on how to support information management for those methods to avoid double work and improve their comparability. This paper presents identified potentials and proposes a solution architecture. This solution architecture has been implemented and tested based on the methods LiDS (Lifecylce Design Strategies) Wheel [2] and PSI (Product Sustainability Index) [3].

2. State of the art

A major share of published articles on sustainable product development sets a focus on the question how sustainability can be embedded into design processes of producing companies. Various means for supporting decision making of actors involved in the design process were developed (cf. [4]). Several authors proposed criteria for method classification, e.g. design stage appropriateness [5] or the type of given recommendation [6]. According to Baumann et al. corresponding design methods can be classified into checklists/guidelines, rating/ ranking tools, software/expert systems, methodologies as well as in analytic and organizational tools [7]. Checklists provide qualitative generic support for design synthesis but often lack of specitivity for supporting product dependent design decisions. Rating & ranking tools, e.g. LiDS-Wheel, enable simple comparisons between decision alternatives on a semi-quantitative basis, whereas analytical tools focus on quantitative assessment of

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environmental/sustainability impact. Life Cycle Assessment, as an example for a mature and commonly used analytic method [8], is already supported by several software tools, e.g. GaBI or SimaPro and first approaches for integrating LCA into the engineering workspace (e.g. Solidworks Sustainability Pro) are available. Expert systems like the G.EN.ESI software platform & methodology support the interplay between design methods (in particular Checklists, Life Cycle Assessment, Life Cycle Costing, Social Life Cycle Assessment), specific models of lifecycle phases (e.g. disassembly) and PLM/CAD [9]. The approach GREENESYS [10] focuses on selection of design methods and tools based on the project context.

Leibrecht et al. developed an information platform which connects CAD, an assessment tool and a lifecycle modeler to assess the sustainability of product variants based on an LCA [11]. Since they pursue a quantitative approach the solution is primarily designed for embodiment design and detailed design (cf. VDI 2221).

3. Designing the information platform

3.1 Requirements and solution elements

In the course of a previous study 50 methods for sustainable product development (SPD) were analysed and classified [12]. Target of the study was to enable design engineers to select and combine existing SPD methods in order to prove sustainability related milestone targets in a development project. A case study was conducted which focused on the redesign of a turbocharger. Within the course of the development project the approach for combining different SPD methods was tested by applying nine design methods in requirements definition, conceptual and embodiment design.

The diversity of applied approaches was experienced as beneficial since it enabled a multilateral view on the product which cannot be achieved by one single perspective. An insight which was gathered in the course of the case study was a significant overlap of information which different methods require. Especially information considering the product lifecycle (e.g. lifetime or energy consumption of the product) needed to be specified for several methods. The main effort for applying a method is the search for information.

Often information sets required by methods are further not sufficiently specified, e.g. by factors which should be considered when assessing reusability of a product.

The analyzed rating & ranking methods deliver requirements on a product which can be considered from a sustainability perspective and provide a means to assess product properties in an early stage of product development. The requirements are associated to product properties (e.g. weight). Adoption costs of product characteristics increase during the course of a product development project. Requirements should thus be verified as early as possible. However, if only solution concepts or basic product characteristics such as a technology are defined, assessing product properties is related to a high effort and a high uncertainty. Rating & ranking tools use a semi- quantitative scale to estimate product properties. This implies, the magnitude is normalized to a scale, e.g. from 1 to 10. The normalization allows method users to combine sustainability indicators where quantitative values are available and indicators which can be only vaguely estimated.

Supporting the application of different rating & ranking methods was considered as most promising as those methods propose the highest flexibility especially in early phases of product development. The aim of the research was to design, implement and test a solution for an information platform which supports different rating and ranking methods. The solution is aimed at facilitating the application of different methods to get a more holistic view on the product and to reduce application time especially for information search. Table 1 displays the requirements which were derived from the case study [cf. 12]. They are arranged to the categories information management, specification of method concepts, specification of calculation and visualization.

Table 1 Requirements and solution elements

	Identified potential	Requirements	Solution concepts
A	• Different naming of method concepts or undefined links between concepts • Information must be inserted several times for different method	• Links between different concepts can be identified • Previously inserted values can be reused	• Information model to link concepts (ontology) • A database to store values for method concepts
B	• The meaning and calculation of method concepts is sometimes not specific • General method concepts must be adapted to product specific context	• Explanation of method concepts is provided on demand • Individual explanation can be inserted	• Semantic wiki which allows users to read and insert explanations and best practices
C	• Often factors are provided to rate an indicator but not how to calculate a value for the method concept based on these factors • Values must be calculated manually again once one factor is changed. • The combination of quantitative and semi-quantitative assessment provides high flexibility	• Provide a default calculation • Store the applied calculation parametrically to reduce effort if a value or criterion is changed	• User interface to insert information and define further criteria and the calculation of method concepts • Store default calculation in information base
D	• Only some methods propose visualization in a diagram.	• Allow method results to be visualized in a diagram	• User interface which offers different diagrams

A- Information management B- Specification of method concepts C- Specification of Calculation D- Visualization