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Evolutionary approach for an optimized analysis of product life cycle data

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Abstract

The application of life cycle data of smart products offers new opportunities for the product development process. Nowadays, products often consist of adaptive design variants of an existing product. Taking this into account, the new product development approach called technical inheritance is developed analogous to biological inheritance. This approach considers the intergenerational evolution of design characteristics.

Enhanced smart products are developed within the Collaborate Research Center (CRC) 653 called "Gentelligent Components in Their Lifecycle". These features the capabilities to sense, collect and transfer life cycle data inherently by using genetic product properties and artificial intelligence. By using technical inheritance optimization strategies are currently investigated and the design of gentelligent components is researched. During the technical inheritance various monitoring concepts are applied to realize a targeted algorithmic feedback of lifecycle information from smart products. For a targeted algorithmic feedback of product life cycle information methods of data mining are applied. These include the objectives of data beneficiation as well as information detection. The boundaries of the investigations are determined through the gentelligent components. Therefore highly mechanical loaded systems are in focus. It follows that the physical aspects and specific life cycle incidents are major objects for the monitoring concept of the product life cycle. The approach aims at the integration of an evolutionary algorithm to identify the component specific critical loads as well as the optimal allocation of loads cases. The results of this concept are exemplified by a wheel suspension which is part of the demonstrator of collaborate research center.

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Keywords: Data Mining; Life Cycle Information; Evolutionary Algorithm

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1. Introduction

The application of smart products in the product development processes holds a few challenges for the research [1]. For example these products could be used for methods of X-in-the-Loop [2] or the allocation of life cycle information [3]. In context of the CRC 653 enhanced smart products, called gentelligent components, are developed. Thereby new manufacturing technologies and materials are investigated [4].

In the course of this research center the approach of the technical inheritance is developed. The focused project in the subproject N4 of "CRC 653" is the transmission of principles from the biology into the technical processes and applications [5]. For the technical inheritance the complete life cycle of smart products has considerable meanings. In contrast of the nature-inspired process model [6] and the autogenetic design theory [7] this approach creates an intergenerational view of development processes.

Often new products represent only an adaptive design of previous product generations. The approach of the technical inheritance occupies this fact [8]. One resultant challenge in the research demonstrates the data analysis of life cycle information from gentelligent components. Therefor principles of biology were analyzed and evaluated. At the example of a demonstrator from the CRC 653 a data mining algorithm which is adapted from biological systematics is applied to get useful information for the development process. This includes the objective to adapt the next product generation to their environmental influences.

2. Methodology

Present research investigates the algorithmic feedback of product life cycle information for a design evolution. This process is developed taking account of the technical inheritance. Therefore an intergenerational development process is generated and depicted in Fig. 1.

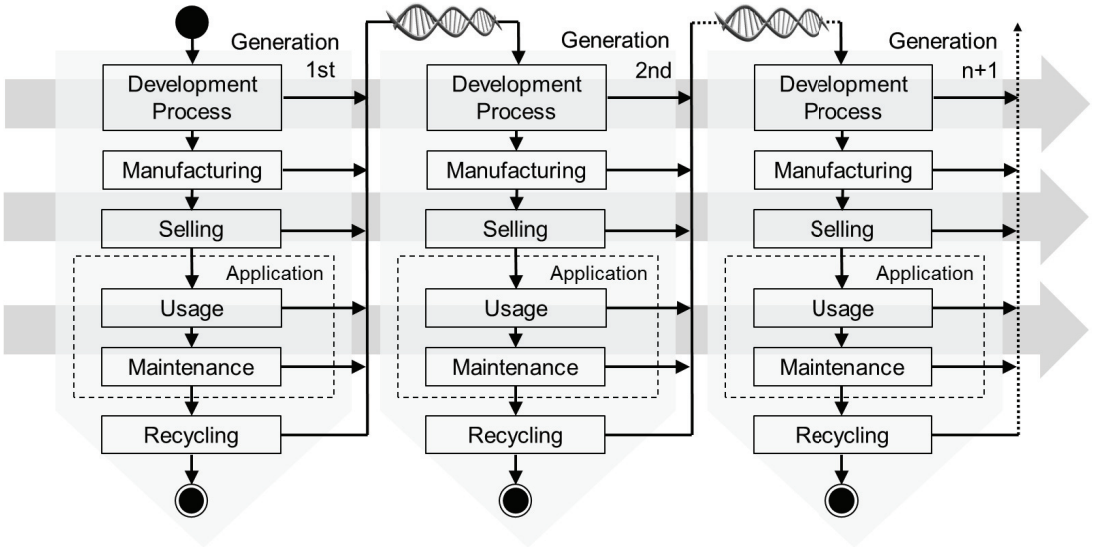

Fig. 1.Intergenerational development process of the technical inheritance.

The fundamental investigation regarding the realization of the technical inheritance is divided into three working packages [9]. The first package investigates the development with the gentelligent technology. Gentelligent components are featured to collect, save and transmit product life cycle information inherently. Methodologies to integrate single gentelligent components into assemblies are investigated to get the usually possible product life cycle information for example usage data. Also approaches for transforming the inherent product data for the application in development process, like elongation at defined points on the component to acting forces at junction points of the assembly, are analyzed. In addition methods of data mining are integrated in the development process