

Book of Abstracts

14. – 15.09.2023

Radebeul bei
Dresden

34. SYMPOSIUM

Design X for X 2023

Veranstaltet durch



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WiGeP

Wissenschaftliche Gesellschaft
für Produktentwicklung



Book of Abstracts

34. Symposium Design for X

14. und 15. September 2023

Radebeul bei Dresden

In einer Zeit, in der die Herausforderungen des Klimawandels immer präsenter werden, ist es von großer Bedeutung, dass wir uns intensiv damit beschäftigen, wie wir mit nachhaltigen Lösungen aus der Produktentwicklung einen Beitrag dazu zu leisten können, eine nachhaltige Lebensführung zu unterstützen. Wir haben heute Methoden und Vorgehensweisen aber auch Technologien zur Verfügung, um nicht nur funktional und qualitativ hochwertige Produkte in kurzer Zeit zu entwickeln. Neue Technologien eröffnen uns vielfältige Möglichkeiten, Nachhaltigkeitsaspekte gezielt bereits in der Entwicklung zu adressieren und in der Lösungsfindung zu berücksichtigen. Damit einher geht auch, dass wir die Vielzahl und Vielfalt von Daten, die im Rahmen des Produktlebenszyklus erzeugt werden, gezielt für die Lösungsfindung nutzen. Vor diesem Hintergrund erhält die Digitalisierung eine weitere Bedeutung. Es gilt nicht allein zu überlegen, wie mittels datengetriebener Methoden unsere Arbeitsprozesse effizienter und effektiver gestaltet werden können. Vielmehr gilt es, das Potential dieser Methoden und Ansätze auch dazu zu nutzen, die Vielfalt und Menge an Daten, die im Rahmen des Produktlebenszyklus entsteht, gerade auch im Sinne einer nachhaltigen Produktgestaltung zu nutzen.

Doch wie können wir diese Chancen nutzen, ohne dabei die Bedürfnisse der Menschen aus den Augen zu verlieren? Die menschenzentrierte Entwicklung rückt daher ebenfalls in den Fokus unserer Diskussionen.

Auch in diesem Jahr möchten wir mit Ihnen auf unserem 34. DFX-Symposium, diesmal erstmalig in Dresden durchgeführt, aktuelle Trends, Erkenntnisse, Methoden in der Produktentwicklung diskutieren und Erfahrungen und Erkenntnisse zu folgenden Themen austauschen:

- Digital Engineering und Systems Engineering
- Leichtbau in der Produktentwicklung
- Augmented und Virtual Reality
- Nutzerzentrierte Produktentwicklung
- Design for X

Wir laden Sie herzlich ein, an den Vorträgen und Diskussionen teilzunehmen, um gemeinsam neue Perspektiven zu gewinnen und Impulse für Ihre eigene Arbeit mitzunehmen. Wir sind überzeugt, dass dieses Symposium Ihnen wertvolle Einblicke und Inspiration bieten wird, um das volle Potenzial von "Design for X" in der Produktentwicklung auszuschöpfen und wünschen Ihnen eine spannende und bereichernde Veranstaltung!

Wir danken an dieser Stelle der Design Society, die vorgestellten Beiträge zu veröffentlichen und somit der Fachwelt zur Verfügung zu stellen.

Ich danke meinen beiden Mitveranstaltern und Kollegen Dieter Krause und Sandro Wartzack für Ihr eingebrachtes Engagement und die konstruktive Zusammenarbeit, meinen Mitarbeitern für die Organisation des Symposiums und natürlich allen Teilnehmerinnen und Teilnehmern für ihre Beiträge. Ich freue mich auf die vielen, interessanten Vorträge, sowie auf die sicherlich intensiven und lebhaften Diskussionen.

Mit freundlichen Grüßen



Prof. Dr.-Ing. Kristin Paetzold-Byhain



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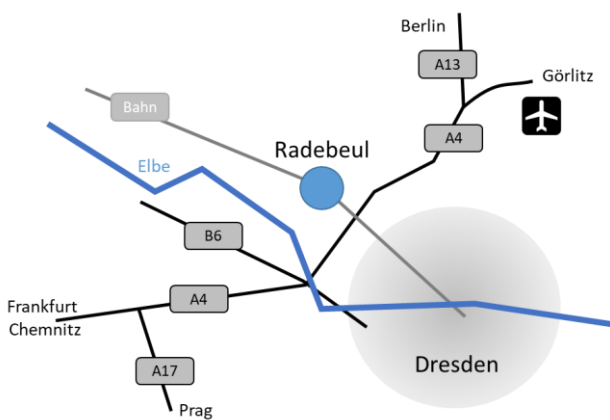
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DfX-Kontakt

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🌐 <https://symposium-dfx.de/>

Themenschwerpunkte

Digital Engineering / Systems Engineering

Augmented Reality / Virtual Reality

Nutzerzentrierte Produktentwicklung

Leichtbau in der Produktentwicklung

Design for X

Mittwoch, 13. September

19:00 – 23:00 Uhr

Get-Together im Radisson Blu Park Hotel & Conference Centre in Radebeul

<https://www.radissonhotels.com/de-de/hotels/radisson-blu-conference-dresden-radebeul>

Donnerstag, 14. September 2023

09:00 - 09:15 Uhr

Begrüßung

09:15 - 09:45 Uhr

Keynote 1 – tba

09:45 - 10:45 Uhr

Session 1 „Leichtbau in der Produktentwicklung“ – Chair: K. Paetzold-Byhain

Using machine learning to increase efficiency in design of experiments for cyclic characterization of fibre-reinforced plastics; *Marc Gadinger, Sandro Wartzack; FAU Erlangen-Nürnberg*

Entwicklungssimulator als Validierungsumgebung für Methoden der Blechkonstruktion; *Ben Maass, Nikola Bursac; TU Hamburg*

10:45 - 11:15 Uhr

Kaffeepause

11:15 - 12:45 Uhr

Session 2 „Nutzerzentrierte Produktentwicklung“ – Chair: S. Wartzack

Vom Konstruktions – zum Produktentwicklungsprozess – Epochenspezifische Lösungsansätze und Institutionalisierungsschritte – 75 Jahre WiGeP; *Günther Luxbacher, Dieter Krause*

Ergonomic Optimization of Human-Machine Systems in Virtual Environments – A Systematic Literature Review Identifying Research Gaps; *Susanne Sutschet, Sven Matthiesen; Karlsruher Institut für Technologie*

Scrum-based Agile Maturity Assessment in Physical Product Development; *Franziska Scharold, Kristin Paetzold-Byhain; TU Dresden*

12:45 - 13:30 Uhr

Mittagspause

13:30 - 15:00 Uhr

Session 3 „Nutzerzentrierte Produktentwicklung“ – Chair: D. Krause

Das Verhältnis zwischen einer gebrauchstauglichen und emotionalen Produktgestalt – Ein Konzept zur Priorisierung relevanter Einflussfaktoren; *Judith van Remmen, Sandro Wartzack; FAU Erlangen-Nürnberg*

Impact of Method Users on the Application of Design Methods - Assessing the Role of Method-related Background Knowledge; *Lukas Pähler, Sven Matthiesen; Karlsruher Inst. für Technologie; Dieter Krause; TU Hamburg*

Towards a Framework for Identifying Relevant Information in regard to Specific Context on the Use Case of Standards and Directives; *Max Layer; Siemens Energy Global GmbH & Co.KG Ralph Stelzer; TU Dresden*

15:00 - 16:00 Uhr

Postersession – Chair: S. Schwach

Liste der Posterbeiträge – siehe Folgeseite

16:00 - 17:00 Uhr

Session 4 „Digital Engineering“ – Chair: K. Paetzold-Byhain

KI-basierte Extrahierung von Anforderungen aus Regularien für die Automobilentwicklung; *Iris Gräßler; Universität Paderborn*



How to control the surface qualities in AM channels?; *Florian Schmitt, Eckhard Kirchner; TU Darmstadt*

17:00 - 18:00 Uhr

Führung Schmalspurbahn

ab 19 Uhr

Abendessen – *Spitzhaus Radebeul, Spitzhausstraße 36, 01445 Radebeul*

- 09:00 - 09:15 Uhr  Begrüßung
- 09:15 - 09:45 Uhr  **Keynote 2:**
Das 3D-CAD-Modell - ein Katalysator für digitale Prozesse und optimierte Verhaltensweisen in Entwicklung und Produktion – *Peter Robl; Siemens AG*
- 09:45 - 10:45 Uhr **Session 5 „Digital Engineering“ – Chair: K. Paetzold-Byhain**
 A Multi-Dimensional Analysis of the Current State of Research into Globally Distributed Product Development; *Simon Nicklas, Alexander Koch; Universität der Bundeswehr München*
 Konstruktionsbegleitende Nachhaltigkeitsbewertung; *Lisa-Marie Nettlebusch, Alexander Hasse; TU Chemnitz*
- 10:45 - 11:15 Uhr Kaffeepause
- 10:55 - 12:45 Uhr **Session 6 „Systems Engineering/Digital Engineering“ – Chair: D. Krause**
 Systems Engineering Potentiale und Anwendungsfälle für die Angebotsphase im Sondermaschinenbau; *Daria Wilke, Roman Dumitrescu; Fraunhofer IEM*
 Strukturbasierte Ähnlichkeitssuchen zur Verbesserung der Komponentenwiederholung im Anlagenbau; *Lorenz Krüger, Kristin Paetzold-Byhain; TU Dresden*
 Generative Models for Feature-Based Product Development as a Basis for Hybrid Decision Making; *Valentin Schemmann, Frank Mantwill; Helmut-Schmidt-Universität Hamburg*
- 12:45 - 13:30 Uhr Mittagspause
- 13:30 - 14:30 Uhr **Session 7 „Digital Engineering“ – Chair: S. Wartzack**
 Vorgehen zur Modellierung des Wertschöpfungsnetzwerks smarterer Produkt-Service-Systeme; *Yevgeni Paliyenko, Matthias Kreimeyer; Universität Stuttgart*
 Structuring and Provision of Manufacturing knowledge through the Manufacturing Resource Ontology; *Max Leo Wawer, Roland Lachmayer; Leibniz Universität Hannover*
- 14:30 - 14:45 Uhr  Verabschiedung
- Posterbeiträge**
-  Feasibility study on time saving potentials of automated workflows in the early design stage of bus body structures; *Lukas Kömm, Kristin Paetzold-Byhain; TU Dresden*
 -  Ontology-based knowledge provision for decision support in product development; *Jessica Pickel, Sandro Wartzack; FAU Erlangen-Nürnberg*
 -  Development of a dynamic complexity costs assessment approach in aviation development; *Maximilian Ridder, Dieter Krause; TU Hamburg*
 -  Continuous simulation of variations during the design of endless fiber reinforced composite structure assemblies ; *Stephan Freitag, Sandro Wartzack; FAU Erlangen-Nürnberg*
 -  Datenqualitätssicherung im Forschungsprozess am Beispiel von Zugversuchen; *Laura Müller, Iryna Mozgova; Universität Paderborn*
 -  Auswirkungen der Umsetzung von Design for Circular Economy Merkmalen auf den Produktentwicklungsprozess; *Merlin Stölzle, Matthias Kreimeyer; Universität Stuttgart*
 -  Proposal for a simulation method to determine the intraoperative torque load for pedicle screws with cellular functional areas; *Franz Leonard Martin, Kristin Paetzold-Byhain; TU Dresden*
 -  A conceptual framework for information linkage and exchange throughout the lifecycle of process plants; *Sebastian Schwoch, Kristin Paetzold-Byhain; TU Dresden*

Mit freundlicher Unterstützung durch

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Using machine learning to increase efficiency in design of experiments for cyclic characterization of fibre-reinforced plastics

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Sandro Wartzack¹

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Efficient characterization of fatigue behavior plays a crucial role in engineering design as it reduces the financial costs associated with expensive experimental tests. Existing methods for characterizing the fatigue behavior of fibre-reinforced plastics have proven inefficient due to the oversight of important design parameters, such as fibre orientations. To address this challenge, we propose an innovative approach based on Gaussian process regression. Our approach integrates previously unaccounted design parameters into the decision-making process, ensuring that optimal design points are selected for testing. By doing so, we maximize the gain of knowledge within the model, resulting in improved efficiency and accurate characterization of fatigue behavior.

Keywords: *fatigue behavior, machine learning, gaussian processes, fibre-reinforced plastics*

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Entwicklungssimulator als Validierungsumgebung für Methoden der Blechkonstruktion

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¹ Institute for Smart Engineering and Machine Elements (ISEM), Hamburg University of Technology (TUHH)

² Institute of Mechanical Engineering (IMW), Clausthal University of Technology

This paper presents the development of an engineering simulator as a validation environment for sheet metal design methods. Therefore requirements of the engineering simulator are identified, such as “the duration of the engineering simulator shall be one day” and “the solutions must be suitable for sheet metal processing on the available machine tools”. This engineering simulator is divided into seven steps, which include introduction (1), ideation (2), prototyping (3), construction (4), CAD-CAM programming (5), production (6) and testing (7). The results of this work can serve as a basis for the development and improvement of other development simulators and be used as a validation environment for the development of design methods.

Keywords: *engineering simulator, validation environment, product generation engineering, sheet metal*

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Vom Konstruktions – zum Produktentwicklungsprozess – Epochenspezifische Lösungsansätze und Institutionalisierungsschritte – 75 Jahre WiGeP

Günther Luxbacher^{1,*}, Dieter Krause²

¹ Priv. Doz. Dr. phil. habil. Freier Historiker

² Hamburg University of Technology, Institute of Product Development and Mechanical Engineering Design

The state of research in the history of science and technology on the science of product research in Germany deals exclusively with methodological items. This essay stresses the contrary side of the product development process for the first time. On the one hand it asks for the requirements for new products and the specific ways these were integrated into product design as a kind of time specific thing knowledge. On the other hand it analyzes, how these procedures were corresponding with institutional innovations apparent in the genesis of WiGeP.

Keywords: *History of technology; Product development process; thing knowledge; institutional progress in Germany*

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Ergonomic Optimization of Human-Machine Systems in Virtual Environments – A Systematic Literature Review Identifying Research Gaps

Susanne Sutschet¹, Carina Spengler¹, Sven Matthiesen^{1,*}

¹ IPEK - Institute of Product Engineering, Karlsruhe Institute of Technology

Enhancing product ergonomics is becoming increasingly important in the development of human-machine systems. But it requires a high development effort due to costly iterations of physical prototypes and user studies. The use of digital human, product, and interaction models as well as an optimizer redesigning the product using ergonomic assessment and optimization algorithms has the potential of reducing this effort. Since there is a variety of methods and models for the ergonomic assessment and design optimization, a systematic literature review based on the PRISMA statement is presented, analyzing 22 relevant studies. The information of application context, ergonomic assessment methods including human posture, external and internal physical human stress, and product design methods were extracted. Research gaps were identified and further research projects were derived. These gaps involve the appropriate selection of ergonomic assessment measures and criteria, a formulation of an objective function based on the ergonomic assessment, and the selection of suitable design parameters for the ergonomic design optimization. These research questions are to be answered based on a specific use case which is to be selected.

Keywords: *Product ergonomics, Digital Human Models, User-centered Design, Design Optimization, Human factors*

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Scrum-based Agile Maturity Assessment in Physical Product Development

Franziska Scharold^{1,*}, Julian Schrof², Kristin Paetzold-Byhain¹

¹ Institute of Machine Elements and Machine Design, Technische Universität Dresden

² Institute for Technical Product Development, Universität der Bundeswehr München

Agile methods are increasingly being implemented in physical product development disciplines, such as automotive development. Once agile methods have been successfully introduced, teams strive to determine the status quo of their agile maturity. For this purpose, agile maturity models have been developed, but these models primarily refer to software development. This work aims at deriving a model that is suitable for teams in physical product development and is based on the agile framework Scrum. The presented Agile Maturity Model consists of eleven dimensions and five levels. In addition, the dimensions that have a high influence on the agile maturity of teams were identified during a study. These are: Agile Events and Iterative Approach, Backlog Management, Team and Agile Values and Principles.

Keywords: *Agile Maturity Assessment, Physical Product Development, Scrum Maturity Model*

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Das Verhältnis zwischen einer gebrauchstauglichen und emotionalen Produktgestalt - Ein Konzept zur Priorisierung relevanter Einflussfaktoren

Judith van Remmen^{1,*}, Dennis Horber¹, Jörg Miebling¹, Sandro Wartzack¹

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Usability and emotionality represent fundamental aspects of user experience. Yet designing an equally usable and emotionally appealing product remains a challenge for product developers, not least due to conflicting goals. Product developers need a deep understanding of what is important to users in different situations of use to make a user-oriented decision between a more usable or emotionally appealing product design. To support product developers in conflicting decision-making situations, the presented systematic approach for the selection and prioritization of context-relevant influencing factors can contribute. By mapping influencing factors and the prioritization using decision theory methods, the importance of the influencing factors in different usage scenarios can be identified.

Keywords: *Usability, emotional design, user experience, user-centred design, decision making*

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Impact of Method Users on the Application of Design Methods - Assessing the Role of Method-related Background Knowledge

Lukas Paehler¹, Olga Sankowski², Selin Üreten², Matthias Eisenmann¹, Dieter Krause², Sven Matthiesen^{1,*}

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By conducting experiments in controlled environments, design researchers test the suitability of design methods for users in practice. However, users in practice bring a variety of background knowledge that is not reflected by the samples with homogeneous knowledge used in controlled environments, especially student samples. To investigate the influence of background knowledge, two method validation experiments with participants with different background knowledge were replicated and evaluated. The results show an influence of background knowledge regarding method use and outcome. Therefore, the background knowledge of the participants must be taken into account when planning method validation experiments in order to ensure that the results are valid for practice.

Keywords: *Design Methods, Design Research, Method Validation, Experimental Research*

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Towards a Framework for Identifying Relevant Information in regard to Specific Context on the Use Case of Standards and Directives

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In a complex landscape of engineering requirements and knowledge represented by standards and directives, navigating and interpreting context-specific information remains a substantial challenge. A novel approach to address this issue is presented, introducing an information extraction framework for identifying product and context-specific, relevant information within unstructured text. The methodology employs Natural Language Processing techniques in a pipeline to parse text from various resources. Different stages for introducing context are proposed based on a trade-off between speed, accuracy, and storage capacity. An initial test focuses on the identification of inspection requirements of piping, while illustrating other potential applications such as an external reference cluster.

Keywords: *Text analysis, Standards, Information Retrieval, Clustering, Natural Language Processing*

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KI-basierte Extrahierung von Anforderungen aus Regularien für die Automobilentwicklung

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¹ Heinz Nixdorf Institute, Chair of Product Creation, Paderborn University

Automotive engineering requires compliance with regulations for certification. In specifications, regulations are referenced, which need to be analyzed manually to elicit requirements. This process is time-consuming and leads to high costs. The aim of this research is to evaluate artificial intelligence (AI) models in terms of extracting requirements automatically from regulations. Relevant AI models are identified in a systematic literature analysis and evaluated using success criteria. The most promising AI models are implemented in a pipeline for requirements extraction. The performance of these AI models is assessed in a comparative study using automotive regulations. The results show which AI models are best suited for this task.

Keywords: *Requirements Engineering, Natural Language Processing, Artificial Intelligence, Automotive Engineering*

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How to control the surface qualities in AM channels?

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Design for Additive Manufacturing maximizes the potential of Additive Manufacturing (AM) through design guidelines and tools. However, a methodological gap remains in integrating hollow structures to enable new functionalities, which is addressed in this contribution. The quantitative working space model (qWSM) is introduced as a tool to enable the examination of surface characteristics and their impact on channel functionalities in AM. The qWSM's dynamic representation of design embodiment supports updates for new design solutions, thus enhancing digital product development efficacy. Utilizing the qWSM, the relationship between surface roughness and state variables like pressure drop are explored. The objective is to refine the AM process and improve functionality through design guidelines.

Keywords: *DFAM, design for X, qWSM, machine elements, sensing machine elements, channels, fluidflow*

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A Multi-Dimensional Analysis of the Current State of Research into Globally Distributed Product Development

Simon J. Nicklas^{1,†,*}, Marvin Michalides^{1,†}, Emir Gadzo^{1,†}, Alexander Koch¹

¹ Institute for Technical Product Development, University of the Bundeswehr Munich

[†] These authors contributed equally to this work

This contribution aims to investigate the challenges and potential solutions associated with the globally distributed development of complex products (GDPD). The research focuses on three key questions: (1) What factors influence GDPD? (2) What challenges and solutions have been encountered in GDPD? (3) What are the research gaps for further exploration in order to advance GDPD research? Through a comprehensive literature review and analysis of 83 relevant papers, the study reveals that both operational and strategic challenges receive equal attention, while normative challenges are relatively neglected. Among the proposed solutions, operational approaches centred around objects and representations emerge as the dominant approach. The study underscores the importance of adopting a balanced approach and conducting further research to address both strategic and normative challenges in GDPD. The findings contribute to enhancing the current understanding of the state of the art in this field and provide a foundation for future research endeavours in this domain.

Keywords: *globally distributed product development (GDPD), distributed collaboration, coordination, engineering management*

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Konstruktionsbegleitende Nachhaltigkeitsbewertung

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The pressure of planetary boundaries led the author to develop a design-related sustainability assessment. That is why several existing methodologies like Resource Efficiency, Material Input per Unit of Service, Life Cycle Assessment and Product Environmental Footprint have been analyzed. These methods are screened in terms of their time horizon, usability and calculation rules. By coupling these different methods in a simplified chain, an internally complex but usable and time-efficient algorithm is created. It continuously supports the product development process and allows decisions and corrections to be made directly and immediately. An evaluation with industry partners on various demonstrators will be an integral part of the research in the future.

Keywords: *Product Design, Life Cycle Assessment, Sustainability Assessment, Planetary Boundaries, Resource Efficiency*

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Strukturbasierte Ähnlichkeitssuchen zur Verbesserung der Komponentenwiederholung im Anlagenbau

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Kristin Paetzold-Byhain²

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² Chair of Virtual Product Development, Technische Universität Dresden

In plant engineering, all products are unique. Nevertheless, it should be possible to find and reuse as many repeat parts as possible. Existing search tools in PDM systems are not suitable for this purpose, since they are too uneconomical in terms of data maintenance in view of the small quantities of plant products, or they are originally designed for retrieving individual parts, but not building structures. This paper proposes the approach of performing repeated searches on the basis of similar building structures and combines concepts of fuzzy searches with the traversal of product structures for this purpose.

Keywords: *plant engineering, part search, PDM, product structure, large assemblies*

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Systems Engineering Potentiale und Anwendungsfälle für die Angebotsphase im Sondermaschinenbau

Daria Wilke^{1,*}, Lynn Humpert¹, Johanna Mansheim¹, Harald Anacker¹, Roman Dumitrescu¹

¹ Fraunhofer Institute for Mechatronic Systems Design IEM

Customer demands for individualization and product complexity are constantly increasing. This poses significant economic and technical challenges in terms of cost, time, and solutions, especially for special purpose machinery. These challenges have a particular impact on the interfaces to the customer, such as the offer phase. Systems Engineering (SE) can help to overcome these challenges. In this paper, the potential benefits of SE are presented and then applied to individual scenarios in the offer phase of a selected company in the special machinery industry. For this purpose, the actual situation of the offer phase was analyzed and presented in four use cases.

Keywords: *Special Purpose Machinery, Mechanical and Plant Engineering, Offer Phase, Systems Engineering, System Model*

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Generative Models for Feature-Based Product Development as a Basis for Hybrid Decision-Making

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This paper investigates the general possibility for applying generative models in the early phase of product development. For this purpose, the fundamentals of feature-based product development are introduced and related to the development methodology VDI 2221 alongside a brief overview of deep generative models. Based on this, a conceptual framework is developed that combines the methods and proposes a collaborative approach. In conclusion, a prototypical implementation is performed by training a StyleGAN2 based on vehicle profiles followed by executing a GANSpace principal component analysis. Finally, the various results are presented and the possibilities of manipulating the generated images based on identified features are discussed and transferred back into the product development process.

Keywords: *Feature-Based Product Development, Deep Generative Models, Principal Component Analysis, StyleGAN2, GANSpace*

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Vorgehen zur Modellierung des Wertschöpfungsnetzwerks smarterer Produkt-Service-Systeme

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Nowadays, enterprises are exposed to dynamic market changes, such as increasing competitive pressure or changing customer needs. They react to this by extending their portfolio with smart product-service systems (smart PSS), thereby increasing the possible value proposition utilizing a data-based value network.

Enterprises require methodological support in developing such complex systems, as smart PSS have special value structures. Current research shows that existing support neglects stakeholders and their interaction. However, their consideration is crucial to improving the chances for successful development and operation. Therefore, in this paper, we present a modeling approach for smart PSS value networks and outline central stakeholders.

Keywords: *Product-Service System (PSS), Smart Systems Engineering, Value Network, Stakeholder Analysis, Modeling Method*

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Structuring and Provision of Manufacturing knowledge through the Manufacturing Resource Ontology

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One challenge in manufacturing-integrated product development is the accessibility of the required manufacturing knowledge. Here, ontologies offer the possibility to structure and formalize information in the form of a knowledge base in order to act as a generic interface to the manufacturing and design specific systems. This paper describes the development of a generic knowledge base called MARON (MANufacturing Restriction ONtology) for the structured representation of manufacturing restrictions via formalized manufacturing capabilities. Using the example of an expert system for process element-oriented manufacturability analysis, it is shown how MARON contributes to automated decision support in the context of manufacturing-oriented design.

Keywords: *design for manufacturing, ontology, manufacturing knowledge, manufacturing resource, computer aided engineering*

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Feasibility study on time saving potentials of automated workflows in the early design stage of bus body structures

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The huge variety in the commercial vehicle segment leads to an enormous amount of work during the development process as structural components or assemblies like bus body structures have to meet the requirements of different vehicle variants. In this case automated workflows provide an option to connect individual process steps and to accelerate development times. A segmented bus body structure is used to allow an easy representation of variants for structural simulations and to simplify the overall problem for a topology optimization. A feasibility study is conducted to investigate the time saving potentials of an automated workflow considering the total process time as well as required man-hours. Additionally, the break-even point of this method is determined.

Keywords: *Product Design, Automated Workflow, Bus Body Structure, Topology Optimization, Variety Management*

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Ontology-based knowledge provision for decision support in product development

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The product development process confronts engineers with numerous decision problems. In this context, it is a challenge to consider all underlying heterogeneous data sources and decision methods to avoid incorrect decisions. Regarding these issues, ontologies offer the possibility to represent knowledge in a structured and adaptable way. Thus, this contribution proposes a methodical conception of a product development ontology and a novel approach to support developers in solving interrelated decision problems by providing relevant knowledge in a target-oriented way. In addition, the application is demonstrated by an exemplary development scenario for the axle design of a micromobility solution.

Keywords: *Ontology, product development process, decision-making, requirements management, knowledge management*

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Development of a dynamic complexity costs assessment approach in aviation development

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The development of avionic products is subject to high-cost pressure due to increasing international competition and small batch sizes. To compete on the global market in a long-term view, potentially arising complexity costs must already be considered in the early phases of the product generation development process. Existing approaches to cost evaluation concentrate on a subsequent evaluation of developed product family concepts alternatives. To avoid a cost- and time-intensive subsequent evaluation of complexity costs, a generic approach for the dynamic consideration of complexity costs within the product generation development process is to be developed by integrating existing approaches for the product generation development and evaluation of variety-induced complexity costs.

Keywords: *complexity costs, product generation development, cost assessment, product family evaluation*

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Continuous simulation of variations during the design of endless fiber reinforced composite structure assemblies

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Using composite materials like endless fiber reinforced plastics offers numerous advantages. Nevertheless, the material properties of composite materials lead to new challenges in the manufacturing and assembly process. Additionally, variations and uncertainties occurring in the different production steps lead to increased production costs. Therefore, appropriate consideration of variations is needed and can be achieved through a continuous analysis of variations and their effects on the parts' quality using methods of tolerance management. The contribution proposes the development of such a simulation strategy..

Keywords: *Fiber reinforced plastics, Tolerance management, Tolerance-cost optimization, Manufacturing simulation, Assembly simulation*

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Datenqualitätssicherung im Forschungsprozess am Beispiel von Zugversuchen

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Progressive digitization throughout the entire product data life cycle requires a more sensitive handling and understanding of data within engineering processes. Regarding engineering research data, the aim is to implement the FAIR data principles (Findable, Accessible, Interoperable, Reusable) to guarantee the post-usability of research data. To ensure the quality of data throughout the entire research process a methodical approach had been developed. Based on the quality categories Intrinsic, Representative, Contextual and Available, the related quality dimensions are considered differentiated along the research data life cycle and presented in a concept. As a use case, this concept is carried out on a tensile test with documentation of results in a research data management system.

Keywords: *data quality assurance, quality dimension, research data management, research data life cycle*

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Auswirkungen der Umsetzung von Design for Circular Economy Merkmalen auf den Produktentwicklungsprozess

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The transformation from a linear to a circular economy seems to be the right way to cope with rising resource consumption by a growing economy. One fundamental aspect to achieve this transition is the development of circular products themselves. Characteristics of circular products are already discussed in academia and often condensed in certain DfX-approaches, known as Design for Circular Economy. Such guidelines often provide general advice for developers rather than contain underlying methodical support to actually implement these criteria. Therefore, this contribution investigates the impact of circular design criteria implementation on the development process, thus uncovering the potential fields of action for methodical support of circular product design development.

Keywords: *circular economy, design guidelines, design for X, product development process, circular product design*

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Proposal for a simulation method to determine the intraoperative torque load for pedicle screws with cellular functional areas

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Due to an ageing population and increased sedentary work, many back problems exist. Severe cases have to be stiffened by surgical therapies with screw-rod systems. However, due to the complex biomechanics of the spine, the screws implanted in the vertebrae often loosen. Additive manufacturing and new modeling methods mean complex lattice structures can now be designed for medical implants. This would make it feasible for the bone not only to grow onto the implant but even into it, thus improving the stiffness of the screw-bone bond and preventing premature loosening. However, this design poses a challenge to the design process of medical implants, as for screws with cellular-designed functional areas, the loads during implantation must be calculated. Therefore, all the calculation procedures were carried out in this work to predict intraoperative loads. For this purpose, the maximum torsional moment and the torsional moment curve were determined analytically according to Wilkie et al. and using explicit dynamic screw-implantation simulations and compared with experimental data. The analytical model showed an apparent overestimation of the torsional moment compared to the numerical model and the experimentally determined data. Based on this, a simulation process for calculating intra-operative loads during implantation and the feedback of the simulation data into the modeling was described.

Keywords: *simulation, medical engineering, pedicle screw, cellular design*

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A conceptual framework for information linkage and exchange throughout the lifecycle of process plants

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Based on the need of unified access to process plant related information across disciplines, companies and lifecycle phases as well as efforts to establish methods of modularization and standardization, this paper introduces a conceptual framework to address these challenges. Based on a systematic literature review and an analysis of data and information flows of two companies, a comprehensive list of requirements is derived. A conceptual framework is proposed based on these requirements and consisting of four linked structures with distinct types of elements. Also, the concept of metadata management within the framework is illustrated which utilizes interfaces to the native Data Management Systems. These interfaces are used to retrieve source data of asset attributes managed within the framework.

Keywords: *information management, data structures, metadata management, modularization, standardization*

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