

Application of smart tools to support change management process

Case study of large power transformers

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Abstract

The ability to manage engineering changes efficiently reflects the agility of an enterprise. Information systems are key enablers for the integration and reliable management of the product development process. Fast, robust, and cost-efficient product adaptation is especially important in one-of-a-kind production. Each product adapted to customer's requests goes through change management process. The case study presents an implementation of information supported tools of the product development design process for large power transformers. A robust design process well supported by information technologies (IT) plays a key role in creating a digital twin and the product's final value. Goal of this research was to develop the product information model and smart supporting tools for change management and integration into the design process. Based on a systematic analysis of the sample company, a model for the complete renewal of information systems was developed and implemented. The results clearly show a considerable drop in engineering changes, increased productivity, and improved business competitiveness.

The conducted research demonstrates that the change management is complex, and therefore requires the cooperation of the entire company. In practice, successful adaptive design means finding the most reliable and the least time-consuming way to design a product that would fully meet the customer's requirements and preferences. The conducted case study has revealed that this is possible by developing holistic solutions and designing standardized systems, combined with highly efficient platform designs that consider modularity and scalability coupled with a consideration to reduce indirect costs. The implementation of information supported design is based on integration of the 3D modeling software with parametric design, the expert system, the computer-aided analyses, and knowledge management. The presented approach enables reuse of successful past digital twins and maximizes the value of customization efforts by reusing in whole or in part for future designs. The results of the featured research are promising in multiple aspects and offer various opportunities for further development.

The proposed framework can be generalized, which makes it applicable in similar business environments and thus helpful for establishing the best-practice guidelines for change management and promoting competitiveness in one-of-a-kind PD processes.

Curriculum vitae – CV

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My background is mechanical engineering. The greater part of my career I have worked in technical information systems, product development and quality systems. It is a combination of different disciplines: processes re-engineering, information technology, quality assurance, and methodology of design. When developing products, I was focused on mechanical vibration, noise reduction and automatic quality control. Polymer gears, sustainability, and cyber-physical systems are in research focus in the last period. Building up systems and looking for solutions is a challenge for me. I am also good at presentations and at mentoring. I believe that my extensive expertise and ability to work in teams is a good foundation for efficient work. Additional information: <https://portal.research.lu.se/en/persons/joze-tavcar>

Education**PhD degree** [1999]

Methods for classification of information flow models in the design development phase, Faculty of Mechanical Engineering, University of Ljubljana

Master degree [1994]

Project management in CAD process, Faculty of Mechanical Engineering, University of Ljubljana

Univ. dipl. Engineer of Mechanical Engineering

Engineering design [1985 - 1990] , Faculty of Mechanical Engineering, University of Ljubljana

Additional training and experiences

- 2021 Internal course on sustainability, LTH, Design science (in progress)
- 2020 Information and communication technology support in the pedagogical process
- 2019 ISO 14001:2015 Internal Auditor Training
- 2018 IATF 16949:2016 Internal Auditor Training
- 2018 Risk assessment for medical devices, SIQ
- 2017 Information security and ISO 27001, SIQ
- 2017 Application of new requests of ISO 13485: 2016 in practice
- 2016 Department Design Engineering, Delft University of Technology, the Netherlands, three months research visit
- 2015 Windchill (PLM) and change management, AUDAX
- 2014 Black belt, Six sigma, Six sigma academy, Matej Hohnjec
- 2014 Internal auditor for information security standard, ISO 27001, SIQ
- 2013 CE mark, SIQ
- 2011 Green belt, Six sigma, Six sigma academy, Matej Hohnjec

Working experiences: 29 years

Design science, Faculty of Engineering - LTH, Lund University, Sweden

[2020 - now] **Senior lecturer, Product development division**

- Additive manufacturing
- Supervision of master thesis, Applying for research funding
- Senior lecture for higher education for courses:
 - Design from thermoplastic materials
 - Engineering design techniques

Faculty of mechanical Engineering, University of Ljubljana, Slovenia

[2011 - 2020] **Lecturer for courses in higher education and researcher**

- Design methodology (Bologna, I. level)
- Engineering design techniques (Bologna, II. level)
- Engineering Design from non-metal materials (Bologna, II. level)
- Technical information system (PhD level, III. level)
- Supervision of 5 PhD students, supervision of 70 final projects
- Coordination of MAPgear research project (in LECAD lab, Smart specialisation project on polymer gears)
- Application project: Development of central drive for e-bike (the project got national golden award for innovation, GZS)

Iskra Mehanizmi, Slovenia

[2006 - 2011] **Head of quality department**

between 2011 - 2018 partly (20 %)

- The development of a quality system according to ISO / TS 16949 in plastic moulding department
- Development of software applications in the field of quality management
- Set up a laboratory for testing of small appliances (lifespan, un-echoic chamber, shaker, contamination checking, etc.)
- Development of quality planning for several products
- Application of a quality system for medical devices
- Installation of a measurement laboratory in plastic moulding department
- Re-engineering of the quality system
- Quality management
- Application of PLM system Windchill (PTC) at Iskra Mehanizmi

Domel Železniki, Slovenia

[2001 – July 2006] **Head of noise and vibrations lab**

- co-ordination of a project: development of the vacuum motors diagnostic system
- member of the vacuum motors project team
- set-up of the lab for noise and vibrations
- co-ordination of a project: development of the dynamic model of vacuum motor
- design of experiments (Taguchi method)
- several analyses of noise and vibrations issues, presentations for customers
- Result: 3 patents in the field of noise reduction

Faculty of Mechanical Engineering, University of Ljubljana

[1991 - 2001] **researcher and assistant**

- Conduction of seminars for industry (AutoCAD, STEP, PLM/PDM)
- computer programming: Project Manager, software for managing of project documentation

- assistant for machine elements, technical documentation, and computer added design (exercises with students)
- project work for industry (Litostroj, IskraEmeco, Domel)
- Phare project: Concurrent engineering in Gorenje d.d., a role of a consultant assistance (1999)
- project work: applying of PDM/PLM system eMatrix in Gorenje (2000 and 2001)

Selected publication in peer reviewed journals:

Changeability and agility enablers in one-of-a-kind product development and design processes, Varl, M., Duhovnik, J. & Tavčar, J., 2021, Research in Engineering Design. 18 p.

A multicriteria function for polymer gear design optimization, Joze Tavcar, Borut Černe, Jože Duhovnik & Damijan Zorko, 2021 Jan, In: Journal of Computational Design and Engineering. p. 1-19 19 p.

Customized Product Development Supported by Integrated Information, Mitja Varl, Jože Duhovnik & Jože Tavčar, 2021, In: Journal of Industrial Information Integration.

Failure modes and life prediction model for high-speed bearings in a through-flow universal motor, Blaž Benedik, Janez Rihtaršič, Janez Povh & Jože Tavčar, 2021, In: Engineering Failure Analysis. p. 2-21 19 p., EFA 105535.

Investigation of the durability and performance of autoclave-cured, woven carbon fiber-reinforced polymer composite gears in mesh with a steel pinion, Damijan Zorko, Jože Tavčar, Roman Šturm & Zoran Bergant, 2021, In: Composite Structures. 273, p. 1-15 15 p., 114250.

Thermo-mechanical modeling of polymer spur gears with experimental validation using high-speed infrared thermography, Borut Cerne, Martin Petkovsek, Joze Duhovnik & Joze Tavcar, 2020 Apr 15, In: Mechanism and Machine Theory. 146, 4, p. 1-22 22 p., 1.

Agile product development process transformation to support advanced one-of-a-kind manufacturing: International Journal of Computer Integrated Manufacturing, Mitja Varl, Joze Duhovnik & Joze Tavcar, 2020, In: International Journal of Computer Integrated Manufacturing. 33, 6, p. 590-608 19 p.

An investigation on the potential of bio-based polymers for use in polymer gear transmissions, Damijan Zorko, Ivan Demšar & Jože Tavčar, 2020, In: Polymer Testing.

A Review of the principles of designing smart cyber-physical systems for run-time adaptation: learned lessons and open issues, Joze Tavcar & Imre Horvath, 2019 Jan 15, In: IEEE Transactions on Systems, Man, and Cybernetics, Part B: Cybernetics. 49, 1, 145-158 13 p.

Durability and design parameters of a Steel/PEEK gear pair, Damijan Zorko, Simon Kulovec, Joze Duhovnik & Joze Tavcar, 2019, In: Mechanism and Machine Theory. 140, p. 825-846 22 p.

Semi-analytical flash temperature model for thermoplastic polymer spur gears with consideration of linear thermo-mechanical material characteristics, Borut Černe, Jože Duhovnik & Joze Tavcar, 2019, In: Journal of Computational Design and Engineering. 6, 4, p. 617-628 12 p.

Engineering change management maturity assessment model with lean criteria for automotive supply chain: Journal of Engineering Design, Joze Tavcar, Ivan Demšar & Jozef Duhovnik, 2018, In: Journal of Engineering Design. 29, 4-5, p. 235-257 23 p.

more publication available at: [https://portal.research.lu.se/portal/en/persons/joze-tavcar\(cb3c1f51-c91c-4b46-9e02-c26358bf88a1\).html](https://portal.research.lu.se/portal/en/persons/joze-tavcar(cb3c1f51-c91c-4b46-9e02-c26358bf88a1).html)