

31st CIRP Conference on Design (CIRP Design 2021)

Procedia CIRP Volume 100

Online
19 – 21 May 2021

Part 1 of 2

Editor:

Eric Lutters

ISBN: 978-1-7138-3101-3

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© by Elsevier B.V.
All rights reserved.

Printed with permission by Curran Associates, Inc. (2021)

For permission requests, please contact Elsevier B.V.
at the address below.

Elsevier B.V.
Radarweg 29
Amsterdam 1043 NX
The Netherlands

Phone: +31 20 485 3911
Fax: +31 20 485 2457

<http://www.elsevierpublishingsolutions.com/contact.asp>

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

PART 1

SIMULATION-BASED DIGITAL TWIN FOR THE MANUFACTURING OF THERMOPLASTIC COMPOSITES	1
<i>André Hürkamp, Ralf Lorenz, Tim Ossowski, Bernd-Arno Behrens, Klaus Dröder</i>	
DEVELOPMENT OF A VOXELIZATION TOOL FOR THE CALCULATION OF VECTOR-BASED WORKPIECE REPRESENTATIONS	7
<i>Thomas Bergs, Oliver Henrichs, Marcel Wilms, Marcel Prümmer, Kristian Arntz</i>	
DESIGN PARAMETERS EFFECTS ON RELATIVE DENSITY OF TRIPLY PERIODIC MINIMAL SURFACES FOR ADDITIVE MANUFACTURING	13
<i>E. A. Ramírez, N. Béraud, F. Pourroy, F. Villeneuve, M. Museau</i>	
INTEGRATION OF MODEL BASED SYSTEM ENGINEERING INTO THE DIGITAL TWIN CONCEPT	19
<i>Yübo Wang, Tanja Steinbach, Jonathan Klein, Reiner Anderl</i>	
EXPLORING DESIGN TO ENVIRONMENT METHODS THROUGH GRASSROOTS INITIATIVES	25
<i>Maud Rio, Benjamin Tyl</i>	
EXTRACTING FUNCTIONAL REQUIREMENTS FROM DESIGN DOCUMENTATION USING MACHINE LEARNING	31
<i>Haluk Akay, Sang-Gook Kim</i>	
MODEL DESIGN AND FINITE ELEMENT ANALYSIS OF A TRACTION LINK OF A RAILCAR	37
<i>Ilesanmi Daniyan, Khumbulani Mpofu, Rumbidzai Muvunzi, Festus Fameso, Boitumelo Ramatsetse</i>	
EMBEDDED VISION DEVICE INTEGRATION VIA OPC UA: DESIGN AND EVALUATION OF A NEURAL NETWORK-BASED MONITORING SYSTEM FOR INDUSTRY 4.0	43
<i>Sascha Julian Oks, Sebastian Zöllner, Max Jalowski, Jonathan Fuchs, Kathrin M. Möslein</i>	
DATA ANALYTICS FOR TIME CONSTRAINT ADHERENCE PREDICTION IN A SEMICONDUCTOR MANUFACTURING USE-CASE	49
<i>Marvin Carl May, Sören Maucher, Andrea Holzer, Andreas Kuhnle, Gisela Lanza</i>	
AN ONTOLOGY MODEL TO SUPPORT THE AUTOMATED DESIGN OF AQUAPONIC GROW BEDS	55
<i>Rabiya Abbasi, Pablo Martinez, Rafiq Ahmad</i>	
MODEL BASED SYSTEMS ENGINEERING AS ENABLER FOR RAPID ENGINEERING CHANGE MANAGEMENT	61
<i>Maximilian Meißner, Georg Jacobs, Patrick Jagla, Jonathan Sprehe</i>	
MODULARIZATION OF JOINING ELEMENTS IN HIGH VARIETY MANUFACTURING INDUSTRIES	67
<i>Derk Hendrik Dominick Eggink, Marco Wilhelm Groll</i>	

IMPACT OF CIRCULAR DESIGN OF LITHIUM-ION BATTERIES ON SUPPLY OF LITHIUM FOR ELECTRIC CARS TOWARDS A SUSTAINABLE MOBILITY AND ENERGY TRANSITION	73
<i>America Rocio Quinteros-Condoretty, Saeed Rahimpour Golroudbary, Laura Albareda, Bernardo Barbiellini, Ayberk Soyer</i>	
ADAPTING PRODUCT ARCHITECTURE TO ADDITIVE MANUFACTURING THROUGH CONSOLIDATION AND SEPARATION	79
<i>Jannik Reichwein, Kris Rudolph, Johannes Geis, Eckhard Kirchner</i>	
APPLYING TOOLS FOR END OF USE OUTLOOK IN DESIGN FOR RECIRCULATION	85
<i>Jutta Hildenbrand, Emma Lindahl, Sasha Shahbazi, Martin Kurdve</i>	
USING SYSML TO SUPPORT IMPACT ANALYSIS ON STRUCTURAL DYNAMICS SIMULATION MODELS	91
<i>Patrick Jagla, Georg Jacobs, Justus Siebrecht, Stefan Wischmann, Jonathan Sprehe</i>	
COLLABORATIVE MANUFACTURING DESIGN: A MIXED REALITY AND CLOUD-BASED FRAMEWORK FOR PART DESIGN	97
<i>Dimitris Mourtzis, John Angelopoulos, Nikos Panopoulos</i>	
INTEGRATION OF LEARNING EFFECTS IN THE DESIGN OF SHIPBUILDING NETWORKS	103
<i>Jan Sender, Benjamin Illgen, Steffen Klink, Wilko Flügge</i>	
A VALVE CLOSING BODY AS A CENTRAL SENSORY-UTILIZABLE COMPONENT	109
<i>Benjamin Kraus, Florian Schmitt, Kay-Eric Steffan, Eckhard Kirchner</i>	
DATA ADMINISTRATION SHELL FOR DATA-SCIENCE-DRIVEN DEVELOPMENT	115
<i>Andreas Löcklin, Hannes Vietz, Dustin White, Tamás Ruppert, Michael Weyrich</i>	
SIMPLIFICATION AND UNFOLDING OF 3D MESH MODELS: REVIEW AND EVALUATION OF EXISTING TOOLS	121
<i>Zohreh Sohrabi Gharehtappeh, Qingjin Peng</i>	
TRANSFER LEARNING AS AN ENABLER OF THE INTELLIGENT DIGITAL TWIN	127
<i>Benjamin Maschler, Dominik Braun, Nasser Jazdi, Michael Weyrich</i>	
VIRTUAL REALITY ENVIRONMENT FOR INDUSTRIAL ROBOT CONTROL AND PATH DESIGN	133
<i>Theodoros Toghias, Christos Gkournelos, Panagiotis Angelakis, George Michalos, Sotiris Makris</i>	
IMPACT OF DISCRETIZATION DISCREPANCY IN MAPPING QUALITY DEPENDING ON MESH DISPLACEMENT AND ROTATION	139
<i>Jérôme Wagner, André Hürkamp, Jan P. Beuscher, Raphael Thater, Klaus Dröder</i>	
NEW DESIGN FOR ASSEMBLY (DFA) METHODOLOGY FOR LARGE AND HEAVY PARTS ASSEMBLED ON SITE	145
<i>Iñigo Ezpeleta, Unai Pujana, Inge Isasa, Jokin Ayerbe, Daniel Justel</i>	
ACTIVE CONTROL OF BLANKHOLDER IN SHEET METAL STAMPING	151
<i>M. Brun, A. Ghiotti, S. Bruschi, S. Filippi</i>	

GAMIFICATION IN INDUSTRIAL SHOPFLOOR – DEVELOPMENT OF A METHOD FOR CLASSIFICATION AND SELECTION OF SUITABLE GAME ELEMENTS IN DIVERSE PRODUCTION AND LOGISTICS ENVIRONMENTS	157
<i>Robin Sochor, Johannes Schenk, Klaus Fink, Julia Berger</i>	
SMART STANDARDS - CONCEPT FOR THE AUTOMATED TRANSFER OF STANDARD CONTENTS INTO A MACHINE-ACTIONABLE FORM	163
<i>Dominik Ehring, Janosch Luttmer, Robin Pluhnau, Arun Nagarajah</i>	
PRODUCTION-ORIENTED DESIGN OF ELECTRIC TRACTION DRIVES WITH HAIRPIN WINDING	169
<i>Jürgen Fleischer, Ludwig Hausmann, Felix Wirth</i>	
DESIGN AND SIMULATION OF AN AUTOMATED ROBOTIC MACHINING CELL FOR CROSS-LAMINATED TIMBER PANELS	175
<i>Emanuel Martinez Villanueva, Harshavardhan Mamledesai, Pablo Martinez, Peyman Poostchi, Rafiq Ahmad</i>	
APPLICATION OF VIRTUAL ENGINEERING TOOLS TO SUPPORT DESIGN OPTIMIZATION: A CASE STUDY ON A CRYOGENIC MACHINING SYSTEM.....	181
<i>Panagiotis Stavropoulos, Thanassis Souflas, Nikolas Porevopoulos, Harry Bikas</i>	
SAVE: SECURITY & SAFETY BY MODEL-BASED SYSTEMS ENGINEERING ON THE EXAMPLE OF AUTOMOTIVE INDUSTRY.....	187
<i>Sergej Japs, Harald Anacker, Roman Dumitrescu</i>	
AN ARTIFICIAL INTELLIGENCE APPROACH FOR THE IN-LINE EVALUATION OF STEELS MECHANICAL PROPERTIES IN ROLLING	193
<i>T. Magro, A. Ghiotti, S. Bruschi, A. Ferraiuolo</i>	
METHODOLOGY FOR INTEGRATED ADDITIVE-SUBTRACTIVE PROCESS CHAIN GENERATION	199
<i>Moritz Wollbrink, Tammo Dannen, Kristian Arntz, Marcel Prümmer, Thomas Bergs</i>	
CREATING DIGITAL PRODUCTS IN ENGINEERING COMPANIES – A PRACTITIONER’S REVIEW	205
<i>Eike Permin, Thomas Vollmer, Dennis Grunert, Robert Schmitt</i>	
FAST DEVELOPMENT CYCLE FOR THE DESIGN OF INDUSTRIAL GRIPPERS	211
<i>Oliver Jorg, Gualtiero Fantoni</i>	
INTEGRATED DESIGN – MULTI-VIEW APPROACH FOR PRODUCTION SYSTEMS DESIGN	217
<i>Juan Camilo Gomez Echeverri, Jean-Yves Dantan, Xavier Godot</i>	
IMPACT ASSESSMENT OF DESIGN GUIDELINES IN THE CONCEPTUAL DEVELOPMENT OF AIRCRAFT PRODUCT ARCHITECTURES.....	223
<i>Giovanni Formentini, Claude Cuiller, Pierre-Eric Dereux, Francois Bouissiere, Claudio Favi</i>	
ENGINEERING DESIGN IN FOOD-PACKAGING INDUSTRY: THE CASE STUDY OF A TUNA CANNING MACHINE.....	229
<i>Giovanni Formentini, Claudio Favi, Fabrizio Moroni, Alessandro Pirondi</i>	
A CAD-BASED DESIGN FOR MANUFACTURING METHOD FOR CASTED COMPONENTS	235
<i>Claudio Favi, Marco Mandolini, Federico Campi, Michele Germani</i>	

ANALYZING SOCIO-TECHNICAL RISKS IN IMPLEMENTATION OF INDUSTRY 4.0-USE CASES	241
<i>Stefan Gabriel, Tobias Grauthoff, Robert Joppen, Arno Kühn, Roman Dumitrescu</i>	
IDENTIFICATION OF DEPENDENCIES BETWEEN PRODUCT PARAMETERS AND PROCESS STAKEHOLDERS.....	247
<i>Ricarda Riedel, Georg Jacobs, Fabian Wyrwich, Justus Siebrecht</i>	
V-MODEL BASED DEVELOPMENT OF CYBER-PHYSICAL SYSTEMS AND CYBER- PHYSICAL PRODUCTION SYSTEMS	253
<i>Iris Gräßler, Dominik Wiechel, Daniel Roesmann, Henrik Thiele</i>	
INTEROPERABILITY OF CAD MODELS AND SYSML SPECIFICATIONS FOR THE AUTOMATED CHECKING OF DESIGN REQUIREMENTS	259
<i>Rihab Brahmi, Moncef Hammadi, Nizar Aifaoui, Jean-Yves Choley</i>	
ENABLING NON-ENGINEERS TO USE ENGINEERING TOOLS: INTRODUCING PRODUCT DEVELOPMENT TO PUPILS USING KNOWLEDGE-INTEGRATING SYSTEMS	265
<i>Jonas Conrad, Stephan Fox, Phyllis Hofmann, Christoph Klahn, Mirko Meboldt</i>	
THE PROTOTYPING FUNGIBILITY FRAMEWORK.....	271
<i>Mark Goudswaard, Chris Snider, James Gopsill, David Jones, Ben Hicks</i>	
ACTIVE PREFERENCE LEARNING IN PRODUCT DESIGN DECISIONS	277
<i>Nicolas Desmedt, Vicky Iliopoulou, Carlos Lopez, Kurt De Grave</i>	
TOWARDS INTEGRATED VERSION CONTROL OF VIRTUAL AND PHYSICAL ARTEFACTS IN NEW PRODUCT DEVELOPMENT: INSPIRATIONS FROM SOFTWARE ENGINEERING AND THE DIGITAL TWIN PARADIGM	283
<i>David Jones, Aydin Nassehi, Chris Snider, James Gopsill, Ben Hicks</i>	
TOWARDS AN AMBIDEXTROUS INNOVATION MANAGEMENT MATURITY MODEL	289
<i>Nadine Niewöhner, Nadja Lang, Laban Asmar, Daniel Röltgen, Roman Dumitrescu</i>	
IMPROVED DESIGN FLEXIBILITY OF OPEN ROBOT CELLS THROUGH TOOL-CENTER- POINT MONITORING.....	295
<i>Christian Deuerlein, Fabian Müller, Julian Seßner, Peter Heß, Jörg Franke</i>	
DERIVATION OF SOCIO-TECHNICAL SOLUTION PATTERNS FOR INDUSTRY 4.0 PROBLEM CLASSES	301
<i>Daniela Hobscheidt, Arno Kühn, Roman Dumitrescu</i>	
CYBER-PHYSICAL-SYSTEM FOR REPRESENTING A ROBOT END EFFECTOR.....	307
<i>Fabian Müller, Christian Deuerlein, Michael Koch</i>	
THE CUSTOMER JOURNEY IN A PRODUCT-SERVICE SYSTEM BUSINESS MODEL.....	313
<i>Eduardo Key Azzine Shiratori, Adriana Hofmann Trevisan, Janaina Mascarenhas</i>	
MULTI-DOMAIN SIMULATION UTILIZING SYSML: STATE OF THE ART AND FUTURE PERSPECTIVES.....	319
<i>Christian Nigischer, Sébastien Bougain, Rainer Riegler, Heinz Peter Stanek, Manfred Grafinger</i>	
CIRCULAR ECONOMY ACTIONS IN BUSINESS ECOSYSTEMS DRIVEN BY DIGITAL TECHNOLOGIES.....	325
<i>Adriana Hofmann Trevisan, Isabela Simões Zacharias, Camila Gonçalves Castro, Janaina Mascarenhas</i>	

FEATURE VISUALIZATION WITHIN AN AUTOMATED DESIGN ASSESSMENT LEVERAGING EXPLAINABLE ARTIFICIAL INTELLIGENCE METHODS	331
<i>Raoul Schönhof, Artem Werner, Jannes Elstner, Boldizsar Zopcsak, Marco Huber</i>	
DESIGN TOOL FOR DYNAMIC LOADING CONDITIONS: A COUPLED MULTI-LEVEL APPROACH.....	337
<i>Styan Zwerus, Marnix Kulman, Stefan Kamphuis, Wessel W. Wits</i>	
FRAMEWORK FOR AN AGILE, DATABASED DEVELOPMENT	343
<i>Michael Riesener, Christian Dölle, Hendrik Lauf, Günther Schuh</i>	
ARTIFICIAL INTELLIGENCE IN ENGINEERING: EVOLUTION OF VIRTUAL PRODUCT DEVELOPMENT IN THE CONTEXT OF MEDICAL DEVICE INDUSTRY	349
<i>Gregor M. Schweitzer, Michael Bitzer, Michael Vielhaber</i>	
IMPLEMENTATION OF MODEL-BASED DEFINITION AND PRODUCT DATA MANAGEMENT FOR THE OPTIMIZATION OF INDUSTRIAL COLLABORATION AND PRODUCTIVITY	355
<i>Konstantinos Rinos, Nikolaos Kostis, Emmanouil Varitis, Vasileios Vekis</i>	
DEVELOPMENT OF AN AI-BASED EXPERT SYSTEM FOR THE PART- AND PROCESS- SPECIFIC MARKING OF MATERIALS	361
<i>Rainer Müller, Leenhard Hörauf, Dirk Burkhard</i>	
RELATIONSHIP AND DEPENDENCIES BETWEEN FACTORS AFFECTING NEW PRODUCT DEVELOPMENT PROCESS: AN INDUSTRIAL CASE STUDY	367
<i>Afifa Rahatulain, Tahir Naseer Qureshi, Antonio Maffei, Mauro Onori</i>	
TOWARDS GENERATIVE DESIGN IN THE DEVELOPMENT OF MECHATRONIC INTEGRATED DEVICES (MID).....	373
<i>Aschot Kharatyan, Christoph Jürgenhake, Roman Dumitrescu</i>	
KNOWLEDGE TRANSFER AND ENGINEERING METHODS FOR SMART-CIRCULAR PRODUCT SERVICE SYSTEMS.....	379
<i>Friedrich Halstenberg, Jasmin Dönmez, Mark Mennenga, Christoph Herrmann, Rainer Stark</i>	
DISTINGUISHING ARTEFACTS: EVALUATING THE SATURATION POINT OF CONVOLUTIONAL NEURAL NETWORKS.....	385
<i>Ric Real, James Gopsill, David Jones, Chris Snider, Ben Hicks</i>	
ANALYSIS OF COMMON FUNCTION MODELS FOR MECHATRONIC PRODUCTS	391
<i>Anton Dybov, Rainer Stark</i>	
AI-BASED KNOWLEDGE EXTRACTION FOR AUTOMATIC DESIGN PROPOSALS USING DESIGN-RELATED PATTERNS.....	397
<i>Carmen Krahe, Maksym Kalaidov, Markus Doellken, Thomas Gwosch, Sven Matthiesen</i>	
HOW TO MANAGE DISRUPTIVE INNOVATION - A CONCEPTUAL METHODOLOGY FOR VALUE-ORIENTED PORTFOLIO PLANNING	403
<i>Simon Weinreich, Tarik Sahin, Tobias Huth, Helmut Breimesser, Thomas Vietor</i>	
DUST-RESISTANT MICROTHERMAL MASS-FLOW PITOT-TUBE FOR FIXED-WING DRONES (UAV).....	409
<i>Julian Ferchow, Stephanie Vogt, Matthias Schibli, Mirko Meboldt</i>	

IMPLEMENTING INNOVATIVE GAZE ANALYTIC METHODS IN DESIGN FOR MANUFACTURING: A STUDY ON EYE MOVEMENTS IN EXPLOITING DESIGN GUIDELINES	415
<i>Markus Doellken, Juan Zapata, Nelius Thomas, Sven Matthiesen</i>	
APPROACH OF SIMULATION DATA MANAGEMENT FOR THE APPLICATION OF THE DIGITAL SIMULATION TWIN	421
<i>Benjamin Röhm, Bennett Emich, Reiner Anderl</i>	
INTEGRATION OF AGILE PRACTICES IN THE PRODUCT DEVELOPMENT PROCESS OF INTELLIGENT TECHNICAL SYSTEMS	427
<i>Stefan Gabriel, Nadine Niewoehner, Laban Asmar, Arno Kühn, Roman Dumitrescu</i>	
SKILL-BASED WORKER ASSIGNMENT IN A MANUAL ASSEMBLY LINE	433
<i>Iris Gräßler, Daniel Roesmann, Chiara Cappello, Eckhard Steffen</i>	
METHODOLOGY FOR ITERATIVE SYSTEM MODELING IN AGILE PRODUCT DEVELOPMENT	439
<i>Michael Riesener, Christian Doelle, Stefan Perau, Philipp Lossie, Guenther Schuh</i>	

PART 2

QUANTIFICATION OF COMPLEXITY IN CYBER-PHYSICAL SYSTEMS BASED ON KEY FIGURES	445
<i>Michael Riesener, Christian Dölle, Alexander Keuper, Marc Fruntke, Guenther Schuh</i>	
INTEGRATIVE DATA PROCESSING FOR CYBER-PHYSICAL OFF-SITE AND ON-SITE CONSTRUCTION PROMOTING CO-DESIGN	451
<i>Carsten Ellwein, Alexander Reichle, Melanie Herschel, Alexander Verl</i>	
UML SEQUENCE DIAGRAM TO AXIOMATIC DESIGN MATRIX CONVERSION: A METHOD FOR CONCEPT IMPROVEMENT FOR SOFTWARE IN INTEGRATED SYSTEMS	457
<i>Rutuja Karampure, Chu Yi Wang, Yash Vashi</i>	
A HEURISTIC APPROACH TO DETECT CAD ASSEMBLY CLUSTERS	463
<i>Brigida Bonino, Roberto Raffaeli, Marina Monti, Franca Giannini</i>	
REDESIGNING A FLEXURAL JOINT FOR METAL-BASED ADDITIVE MANUFACTURING	469
<i>Edoardo Ercolini, Flaviana Calignano, Manuela Galati, Marco Viccica, Luca Iuliano</i>	
OBSERVATIONS ON MODULAR PRODUCT STRUCTURES BASED ON TEACHING PRODUCT MODULARISATION	476
<i>Jarkko Pakkanen, Timo Lehtonen, Tero Juuti</i>	
DESIGN FOR ROBOT ASSEMBLY: CHALLENGES OF ONLINE EDUCATION	482
<i>Fei Yu, Elias Ribeiro Da Silva</i>	
COBOTS IN MAXILLOFACIAL SURGERY – CHALLENGES FOR WORKPLACE DESIGN AND THE HUMAN-MACHINE-INTERFACE	488
<i>Florian Beuss, Frederik Schmatz, Marten Stepputat, Fabian Nokodian, Bernhard Frerich</i>	
LIGHTWEIGHT DESIGN IN PRODUCT DEVELOPMENT: A CONCEPTUAL FRAMEWORK FOR CONTINUOUS SUPPORT IN THE DEVELOPMENT PROCESS	494
<i>Albert Albers, Jan Holoch, Sven Revfi, Markus Spadinger</i>	

DIGITAL AND DISTRIBUTED PROJECT MANAGEMENT IN MECHANICAL ENGINEERING STUDIES – A CASE STUDY	500
<i>Carsten Stechert</i>	
A DIGITAL TWIN ARCHITECTURE FOR EFFECTIVE PRODUCT LIFECYCLE COST ESTIMATION.....	506
<i>Maryam Farsi, Dedy Ariansyah, John Ahmet Erkoyuncu, Andrew Harrison</i>	
SITUATION- AND NEED-BASED METHOD RECOMMENDATION FOR COACHING AGILE DEVELOPMENT TEAMS	512
<i>Manuel Niever, Nadja Trefz, Jonas Heimicke, Carsten Hahn, Albert Albers</i>	
INTEGRATING HUMAN FACTORS IN THE MODEL BASED DEVELOPMENT OF CYBER-PHYSICAL PRODUCTION SYSTEMS	518
<i>Iris Gräßler, Dominik Wiechel, Daniel Roesmann</i>	
A DESIGN FRAMEWORK FOR TECHNOLOGY PRIORITISATION IN THE CONTEXT OF THROUGH-LIFE ENGINEERING SERVICES	524
<i>Jie Chi, Christina Latsou, John Ahmet Erkoyuncu, Alex Grenyer, Simon Brocklebank</i>	
AUTOMATED 3D SCAN BASED CAD-REPOSITIONING FOR DESIGN AND VERIFICATION IN ONE-OFF CONSTRUCTION	530
<i>Stephan Mönchinger, Robert Schröder, Rainer Stark</i>	
A MULTI-OBJECTIVE APPROACH FOR RESILIENCE-BASED SYSTEM DESIGN OPTIMISATION OF COMPLEX MANUFACTURING SYSTEMS	536
<i>Christina Latsou, John Ahmet Erkoyuncu, Maryam Farsi</i>	
CUSTOMER-ORIENTED DIGITAL DESIGN PROCESS FOR THE DEVELOPMENT AND PRODUCTION OF AN INDIVIDUAL LAST-MILE ELECTRIC VEHICLE	542
<i>Johannes Burkhart, Theresa Breckle, Matthias Merk, Manuel Ramsaier, Ralf Stetter</i>	
FROM PACKAGE AND DESIGN SURFACES TO OPTIMIZATION - HOW TO APPLY SHAPE OPTIMIZATION UNDER GEOMETRICAL CONSTRAINTS	548
<i>Yannis Werner, Philip Thiele, Vijey Subramani Raja Gopalan, Thomas Vietor</i>	
DIGITIZATION OF INDUSTRIAL ENGINEERING PROCESSES USING THE AUGMENTED REALITY TECHNOLOGY: INDUSTRIAL CASE STUDIES	554
<i>Fahmi Bellalouna</i>	
SAMPLING-BASED TOLERANCE ANALYSIS: THE KEY TO ESTABLISH TOLERANCE-COST OPTIMIZATION IN THE PRODUCT DEVELOPMENT PROCESS	560
<i>Martin Hallmann, Benjamin Schleich, Sandro Wartzack</i>	
A PRACTICAL REDESIGN METHOD FOR FUNCTIONAL ADDITIVE MANUFACTURING	566
<i>Weijun Wang, Chen Zheng, Feng Tang, Yicha Zhang</i>	
PRODUCT DEVELOPMENT METHODOLOGY "SCALABILITY"	571
<i>Carolina Gracia Grijota, Raquel Acero, José Antonio Yagüe-Fabra</i>	
COMPARISON OF CAD SYSTEMS FOR GENERATIVE DESIGN FOR USE WITH ADDITIVE MANUFACTURING	577
<i>Stefan Junk, Lukas Burkart</i>	
TOLERANCE OPTIMIZATION FOR SHEET METAL PARTS BASED ON JOINING SIMULATION	583
<i>Hanchen Zheng, Frank Litwa, Martin Bohn, Kristin Paetzold</i>	

DESIGNING SUPPLIER SELECTION STRATEGIES UNDER COVID-19 CONSTRAINTS FOR INDUSTRIAL ENVIRONMENTS	589
<i>Mzougui Ilyas, Silvia Carpitella, Elfelsoufi Zoubir</i>	
CASE STUDY FOR DESIGN OPTIMIZATION USING THE DIGITAL TWIN APPROACH	595
<i>Fahmi Bellalouna</i>	
HAPTIC FEEDBACK IS MORE IMPORTANT THAN VR EXPERIENCE FOR THE USER EXPERIENCE ASSESSMENT OF IN-CAR HUMAN MACHINE INTERFACES	601
<i>Lasse Schölkopf, Mario Lorenz, Mareike Stamer, Lina Albrecht, Johannes Tümler</i>	
SIMULATION-BASED DESIGN: A CASE STUDY IN COMBINING OPTIMIZATION METHODOLOGIES FOR ANGLE-PLY COMPOSITE LAMINATES	607
<i>Evangelos Tyflopoulos, Tarjei Aure Hofset, Anna Olsen, Martin Steinert</i>	
DEVELOPMENT OF AN INDUSTRY 4.0 METHOD AND KNOWLEDGE PLATFORM FOR STRATEGIC TECHNOLOGY IMPLEMENTATION	613
<i>David Schneider, Tobias Huth, Thomas Vietor</i>	
A SYSTEMATIC FOR REALIZING AGILE PRINCIPLES IN THE PROCESS OF MECHATRONIC SYSTEMS DEVELOPMENT THROUGH INDIVIDUAL SELECTION OF SUITABLE PROCESS MODELS, METHODS AND PRACTICES	619
<i>Jonas Heimicke, Gha-Leng Ng, Madita Krüger, Albert Albers</i>	
CROSS-DEPARTMENTAL AND CROSS-DISCIPLINARY PRODUCT DEVELOPMENT – AN INDUSTRY SURVEY ON THE NECESSITY AND FUTURE DEVELOPMENT OF CROSS-DEPARTMENTAL AND CROSS-DISCIPLINARY PERSPECTIVES.....	625
<i>Marc Zuefle, Christoph Rennpferdt, Dieter Krause</i>	
HOW TO USE HUMAN POSE ESTIMATION TO MEASURE THE HAND-ARM MOTION IN CRAFT APPLICATION WITH NO INFLUENCE ON THE NATURAL USER BEHAVIOR.....	631
<i>Sebastian Helmstetter, Johannes Sanger, Rene Germann, Sven Matthiesen</i>	
MODEL-BASED APPLICATION OF THE METHODOICAL PROCESS FOR MODULAR LIGHTWEIGHT DESIGN OF AIRCRAFT CABINS	637
<i>Michael Hanna, Johann Schwenke, Lea-Nadine Schwede, Fabian Laukotka, Dieter Krause</i>	
A MACHINE LEARNING APPROACH TO ESTIMATE PRODUCT COSTS IN THE EARLY PRODUCT DESIGN PHASE: A USE CASE FROM THE AUTOMOTIVE INDUSTRY	643
<i>Frank Bodendorf, Jorg Franke</i>	
METHOD FOR SIMULATIVE REPRODUCTION, VERIFICATION AND TECHNICAL ADAPTATION AS PART OF BIOLOGICAL KINEMATICS STUDIES	649
<i>Robin Loffler, Daniel Rucker, Fabian Muller, Rudiger Hornfeck</i>	
FUNCTION ANALYSIS: GOING FORWARD IN VALUE ANALYSIS	655
<i>Alexis Lalevee, Nade Troussier, Eric Blanco, Mahmoud Chakroun</i>	
CHALLENGING THE ENGINEERING DESIGN PROCESS FOR THE DEVELOPMENT OF FACIAL MASKS IN THE CONSTRAINT OF THE COVID-19 PANDEMIC	660
<i>Giovanni Formentini, Nuria Boix Rodriguez, Claudio Favi, Marco Marconi</i>	
DIGITAL TWINNING FOR PURPOSE-DRIVEN INFORMATION MANAGEMENT IN PRODUCTION	666
<i>Maake Slot, Eric Lutters</i>	

DESIGN OF SENSOR INTEGRATING GEARS: METHODICAL DEVELOPMENT, INTEGRATION AND VERIFICATION OF AN IN-SITU MEMS SENSOR SYSTEM	672
<i>Julian Peters, Lorenz Ott, Matthias Dörr, Thomas Gwosch, Sven Matthiesen</i>	
ATTRIBUTES OF RESEARCH ENVIRONMENTS FOR MODELLING ENGINEERING SIMULATORS FOR DESIGN SUPPORT VALIDATION	678
<i>Manfred Hofelich, Kai Valerian Mantel, Nikola Bursac, Daniel Omidvarkarjan, Thomas Schneider</i>	
DIGITAL TWINS OF PRODUCT FAMILIES IN AVIATION BASED ON AN MBSE- ASSISTED APPROACH	684
<i>Fabian Laukotka, Michael Hanna, Dieter Krause</i>	
SUPPORTING SEMANTIC PLM BY USING A LIGHTWEIGHT ENGINEERING METADATA MAPPING ENGINE	690
<i>Andreas Eiden, Thomas Eickhoff, Jonas Gries, Jens C. Göbel, Thomas Psota</i>	
VARIETY-DRIVEN DESIGN TO REDUCE COMPLEXITY COSTS OF A TIRE CURING PRESS FAMILY	696
<i>Christoph Rennpferdt, Erik Greve, Dieter Krause</i>	
DESIGNING DIE INSERTS BY ADDITIVE APPROACH: A TEST CASE	702
<i>Paolo Cicconi, Marco Mandolini, Federica Santucci, Michele Germani</i>	
SOCIO-TECHNICAL RISK MANAGEMENT IN THE AGE OF DIGITAL TRANSFORMATION -IDENTIFICATION AND ANALYSIS OF EXISTING APPROACHES	708
<i>Joern Steffen Menzefricke, Ingrid Wiederkehr, Christian Koldewey, Roman Dumitrescu</i>	
LEVERAGING SYNTHETIC DATA FROM CAD MODELS FOR TRAINING OBJECT DETECTION MODELS – A VR INDUSTRY APPLICATION CASE	714
<i>Sampsa Kohtala, Martin Steinert</i>	
IDENTIFYING AN OPPORTUNISTIC METHOD IN DESIGN FOR MANUFACTURING: AN EXPERIMENTAL STUDY ON SUCCESSFUL A ON THE MANUFACTURABILITY AND MANUFACTURING EFFORT OF DESIGN CONCEPTS	720
<i>Doellken, Markus, Arndt Lorin, Nelius Thomas, Matthiesen Sven</i>	
OPTIMIZATION OF SUPPORT STRUCTURE IN MULTI-ARTICULATED JOINTS OF NON- ASSEMBLY MECHANISMS	726
<i>Wk Leung, Muhammad Huzaiifa Raza, Ray Y. Zhong</i>	
STIFFNESS MODULATION FOR SOFT ROBOT JOINT VIA LATTICE STRUCTURE CONFIGURATION DESIGN	732
<i>Zhiping Wang, Yicha Zhang, Gaofeng Li, Guoqing Jin, Alain Bernard</i>	
CLASSIFICATION APPROACH FOR HYBRID COMPONENTS IN MECHANICAL ENGINEERING WITH A FOCUS ON ADDITIVE MANUFACTURING	738
<i>Maximilian Ley, Ali Al-Zuhairi, Roman Teutsch</i>	
REVIEW AND MODIFICATION OF DFA2 METHODOLOGY TO SUPPORT DESIGN FOR AUTOMATIC ASSEMBLY (DFAA) IN THE MARITIME INDUSTRY	744
<i>Paul Jose Madappilly, Ola Jon Mork</i>	
IMPROVING DISTRIBUTED COLLABORATION – METHODS FOR IDENTIFICATION AND DEVELOPING OF IMPROVEMENT POTENTIALS	750
<i>Katharina Duehr, Emre Kavakli, Albert Albers</i>	

ANALYZING ITERATIONS IN MECHANICAL DESIGN PROCESSES – A METHOD FOR DATA ACQUISITION IN MESO-LEVEL STUDIES.....	756
<i>Frank Bremer, Fabian Heimberger, Julian Reichard, Sven Matthiesen</i>	
PHOTOGRAMMETRY-BASED 3D SCANNING FOR SUPPORTING DESIGN ACTIVITIES AND TESTING IN EARLY STAGE PRODUCT DEVELOPMENT.....	762
<i>Sampsa Kohtala, Jørgen F. Erichsen, Ole Petter Wullum, Martin Steinert</i>	
AGILE PRODUCT DEVELOPMENT: AN ANALYSIS OF ACCEPTANCE AND ADDED VALUE IN PRACTICE.....	768
<i>Jonas Heimicke, Steffen Kaiser, Albert Albers</i>	
SYSTEMATIC APPROACH TO CONSIDER HRC IN EARLY DESIGN PHASE.....	774
<i>Thomas Koch, Joshua Beck, Stephan Mayer</i>	
ECONOMIC AND ENVIRONMENTAL ASSESSMENT OF BIOMASS SUPPLY CHAIN FOR DESIGN OF TRANSPORTATION MODES: STRATEGIC AND TACTICAL DECISIONS POINT OF VIEW.....	780
<i>Seyed Mojib Zahraee, Saeed Rahimpour Golroudbary, Nirajan Shiwakoti, Peter Stasinopoulos, Andrzej Kraslawski</i>	
A FRAMEWORK FOR GENERATING AGILE METHODS FOR PRODUCT DEVELOPMENT.....	786
<i>Jonas Heimicke, Katharina Dühr, Madita Krüger, Gha-Leng Ng, Albert Albers</i>	
REQUIREMENTS FOR DESIGN REUSE IN OPEN-SOURCE HARDWARE: A STATE OF THE ART.....	792
<i>A. Ezoji, J. F. Boujut, R. Pinqüé</i>	
EVALUATION OF THE APPLICABILITY OF DESIGN FOR SIX SIGMA TO METAL ADDITIVE MANUFACTURING TECHNOLOGY.....	798
<i>Cindy Sithole, Ian Gibson, Sipke Hoekstra</i>	
DESIGN OF A TRAIN CLEANING ROBOT FOR THE TRAIN CARRIAGE INTERIOR.....	804
<i>Nathan Western, Xianwen Kong, Mustafa Suphi Erden</i>	
DEVELOPMENT OF SMART PRODUCTS FOR ELDERLY WITHIN THE INDUSTRY 4.0 CONTEXT: A CONCEPTUAL FRAMEWORK.....	810
<i>Carolina Sallati, Klaus Schützer</i>	
AUGMENTED REALITY FOR IT/OT FAILURES IN MAINTENANCE OPERATIONS OF DIGITIZED TRAINS: CURRENT STATUS, RESEARCH CHALLENGES AND FUTURE DIRECTIONS.....	816
<i>Sara Scheffer, Alberto Martinetti, Roy Damgrave, Leo Van Dongen</i>	
EDUCATIONAL TOOL BASED ON A MORPHOLOGICAL MATRIX FOR DESIGN ALTERNATIVE GENERATION FOR USE IN RAILWAY WAGON DESIGN.....	822
<i>Thiago De Lima Gontarski, Régis Kovacs Scalice</i>	
DESIGN TO COST; A FRAMEWORK FOR LARGE INDUSTRIAL PRODUCTS.....	828
<i>Iban Retolaza, Iñigo Ezpeleta, Adrian Santos, Iban Diaz, Felix Martinez</i>	
CASE STUDY ON PRIORITIZING TEST CASES AND SELECTING THE MOST QUALIFIED VALIDATION ENVIRONMENT USING AN OEM'S TRANSMISSION APPLICATION AS AN EXAMPLE.....	834
<i>John Köber, Matthias Behrendt, Albert Albers</i>	

CHALLENGES IN EARLY PHASE OF PRODUCT FAMILY DEVELOPMENT PROCESSES.....	840
<i>Olga Sankowski, Jan Küchenhof, Florian M. Dambietz, Marc Züfle, Kristin Paetzold</i>	
CHARACTERIZATION OF L-PBF LATTICE STRUCTURES GEOMETRIC DEFECTS.....	846
<i>Kévin Ferreira, Nabil Anwer, Charyar Mehdi-Souzani</i>	
TOWARD NON-DEFAULT PARTITIONING FOR COMPOUND FEATURE IDENTIFICATION IN ENGINEERING DESIGN	852
<i>Yifan Qie, Nabil Anwer</i>	
ARTIFICIAL INTELLIGENCE ENHANCED INTERACTION IN DIGITAL TWIN SHOP- FLOOR.....	858
<i>Xin Ma, Jiangfeng Cheng, Qinglin Qi, Fei Tao</i>	
FRAMEWORK APPROACH FOR SMART SERVICE DEVELOPMENT.....	864
<i>Serdar Bulut, Reiner Anderl</i>	
APPLICATION OF THE GENERIC VARIATION OPERATOR IN THE MODEL OF PGE – PRODUCT GENERATION ENGINEERING ONTO THE ELEMENT TYPES OF PROPERTIES AND FUNCTIONS OF TECHNICAL SYSTEMS.....	870
<i>Albert Albers, Joshua Fahl, Tobias Hirschter, Simon Rapp</i>	
ANALYSIS OF THE VARIATION OF THE ELEMENT TYPES OF PROPERTIES AND FUNCTIONS OF TECHNICAL SYSTEMS IN PRODUCT DEVELOPMENT PRACTICE.....	876
<i>Albert Albers, Tobias Hirschter, Joshua Fahl, Simon Rapp</i>	
REALITY-INFUSED SIMULATIONS FOR DASHBOARDING POTENTIAL REALITIES.....	882
<i>Roy Damgrave, Maaïke Slot, Sebastian Thiede, Eric Lutters</i>	

Author Index