

28th CIRP Design Conference 2018

Procedia CIRP Volume 70

Nantes, France
23 – 25 May 2018

Editors:

**Florent Laroche
Alain Bernard**

ISBN: 978-1-5108-6335-4

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 by Curran Associates, Inc. (2018)

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

1. SESSION A1 – DESIGN METHODOLOGY, METHODS AND TOOLS

A BAYESIAN APPROACH TO MODEL CHANGE PROPAGATION MECHANISMS	1
<i>Shirin Mirdamadi, Sid-Ali Addouche, Marc Zolghadri</i>	
SPECIFICATION OF SURFACE ROUGHNESS USING AXIOMATIC DESIGN AND MULTISCALE SURFACE METROLOGY	7
<i>Christopher A. Brown</i>	
CAPABILITY-BASED DESIGN TASK DECOMPOSITION IN HEAVY MILITARY VEHICLE COLLABORATIVE DEVELOPMENT PROCESS	13
<i>Wenjun Liu, Jun Ji, Yiming Yang, Lindong Zhang</i>	
IDENTIFICATION OF AGILE MECHANISMS OF ACTION AS BASIS FOR AGILE PRODUCT DEVELOPMENT	19
<i>G. Schuh, C. Dölle, J. Kantelberg, A. Menges</i>	
DESIGNING SIMPLIFICATION STRATEGY FOR SOLUTIONS ANALYSIS AND SELECTION AT THE ARCHITECTURAL DESIGN STAGE	25
<i>Ricardo Duarte, Michel Mesnard, Antonio Ramos, Jean-Pierre Nadeau, Nicolas Perry</i>	
DEFINING SCALING STRATEGIES FOR THE IMPROVEMENT OF AGILITY PERFORMANCE IN PRODUCT DEVELOPMENT PROJECTS	29
<i>Günther Schuh, Eric Rebentisch, Christian Dölle, Christian Mattern, G. Volevach, Alexander Menges</i>	
AUTOMATED MAINTENANCE PLAN GENERATION BASED ON CAD MODEL FEATURE RECOGNITION	35
<i>Pedro Yopez, Basel Alsayyed, Rafiq Ahmad</i>	
IMPROVING THE KNOWLEDGE TRANSFER FROM RESEARCH TO INDUSTRY BY DEVELOPING DEMAND-ORIENTED DESIGN GUIDELINES FOR FIBRE-REINFORCED PLASTICS	41
<i>Viktoriia Butenko, Albert Albers</i>	
A NEW METHODOLOGY TO ANALYZE THE FUNCTIONAL AND PHYSICAL ARCHITECTURE OF EXISTING PRODUCTS FOR AN ASSEMBLY ORIENTED PRODUCT FAMILY IDENTIFICATION	47
<i>Paul Stief, Jean-Yves Dantan, Alain Etienne, Ali Siadat</i>	
C&C²-AFM - AN EMBODIMENT DESIGN- AND FUNCTION-BASED APPROACH FOR ANALYSIS OF FAILURE MECHANISMS	53
<i>Bartosz Gladysz, Albert Albers</i>	
CAD COMPARISON MODEL FOR DATA REUSE AND MANUFACTURING COST ESTIMATION	59
<i>Mehdi Tlija, Montasser Billah Letaief, Borhen Louhichi</i>	
ASSEMBLY PLANS GENERATION OF COMPLEX MACHINES BASED ON THE STABILITY CONCEPT	66
<i>Akram Bedeoui, Riadh Benhadj, Moez Trigui, Nizar Aifaoui</i>	
ADAPTIVE DESIGN OF ENGINEERING CHANGE MANAGEMENT IN HIGHLY ITERATIVE PRODUCT DEVELOPMENT	72
<i>G. Schuh, J.-P. Prote, M. Luckert, F. Basse, V. Thomson, W. Mazurek</i>	
AGILE TRANSFORMATION AND CORRELATION OF CUSTOMER-SPECIFIC REQUIREMENTS AND SYSTEM-INHERENT CHARACTERISTICS - AN AUTOMOTIVE EXAMPLE	78
<i>Jan-Henrik Schneberger, Tobias Luedeke, Michael Vielhaber</i>	

SESSION A2 – ADDITIVE MANUFACTURING IN PROGRESS

FEATURE-BASED METHODOLOGY FOR DESIGN OF GEOMETRIC BENCHMARK TEST ARTIFACTS FOR ADDITIVE MANUFACTURING PROCESSES	84
<i>Baltej Singh Rupal, Rafiq Ahmad, Ahmed Jawad Qureshi</i>	
MODELING KEY CHARACTERISTICS IN THE VALUE CHAIN OF ADDITIVE MANUFACTURING	90
<i>Yahya Al-Meslemi, Nabil Anwer, Luc Mathieu</i>	

INTEGRATED DESIGN-ORIENTED FRAMEWORK FOR RESOURCE SELECTION IN ADDITIVE MANUFACTURING	96
<i>Uzair Khaleeq Uz Zaman, Mickael Rivette, Ali Siadat, Aamer Ahmed Baqai</i>	
TOPOLOGY OPTIMIZATION FOR ADDITIVE MANUFACTURING USING A COMPONENT OF A HUMANOID ROBOT	102
<i>Stefan Junk, Benjamin Klerch, Lutz Nasdala, Ulrich Hochberg</i>	
PLANNING, EVALUATION AND OPTIMIZATION OF PRODUCT DESIGN AND MANUFACTURING TECHNOLOGY CHAINS FOR NEW PRODUCT AND PRODUCTION TECHNOLOGIES ON THE EXAMPLE OF ADDITIVE MANUFACTURING	108
<i>Alexander Jacob, Karolin Windhuber, Daniel Ranke, Gisela Lanza</i>	
DESIGN FOR MANUFACTURING AND ASSEMBLY KEY PERFORMANCE INDICATORS TO SUPPORT HIGH-SPEED PRODUCT DEVELOPMENT	114
<i>Mary Kathryn Thompson, Ida Kirstine Juel Jespersen, Thomas Kjærgaard</i>	
DESIGN FOR 4D PRINTING: RAPIDLY EXPLORING THE DESIGN SPACE AROUND SMART MATERIALS	120
<i>Germain Sossou, Frédéric Demoly, Ghislain Montavon, Samuel Gomes</i>	

SESSION A3 – TOLERANCING IMPROVEMENTS

A CAD MODEL FOR TOLERANCE ANALYSIS OF NON-RIGID PLANAR PARTS ASSEMBLIES	126
<i>Anis Korbi, Mehdi Tlija, Borhen Louhichi, Abdelmajid Benamara</i>	
OPTIMAL TOLERANCE ALLOCATION BASED ON DIFFICULTY MATRIX USING FMECA TOOL	132
<i>Maroua Ghali, Mehdi Tlija, Nizar Aifaoui</i>	
FAST ANALYSIS OF COMPLIANT ASSEMBLY	138
<i>Yann Ledoux, Denis Teissandier, Vincent Delos</i>	

SESSION B1 – DATA, KNOWLEDGE AND SEMANTIC ASPECTS

DATA-BASED DETERMINATION OF THE PRODUCT-ORIENTED COMPLEXITY DEGREE	144
<i>Günther Schuh, Christian Dölle, Stephan Schmitz, Jan Koch, M. Hoding, Alexander Menges</i>	
INVESTIGATING ORGANIZATIONAL KNOWLEDGE TRANSFORMATION CAPABILITIES IN INTEGRATED MANUFACTURING AND PRODUCT DEVELOPMENT COMPANIES	150
<i>Torgeir Welo, Geir Røingen</i>	
CAD MODELLING BASED ON KNOWLEDGE SYNTHESIS FOR DESIGN RATIONAL	156
<i>Anthony Geromin, Lionel Roucoules, François Malburet, Cédric Lopez</i>	
ANALYTICS CANVAS – A FRAMEWORK FOR THE DESIGN AND SPECIFICATION OF DATA ANALYTICS PROJECTS	162
<i>Arno Kühn, Robert Joppen, Felix Reinhart, Daniel Röltgen, S. Enzber, Roman Dumitrescu</i>	
USING SEMANTIC METADATA FOR CONTINUOUS DEVELOPMENT OF REQUIREMENTS AND GOALS IN THE SMART MOBILITY DOMAIN – AN EMPIRICAL STUDY	168
<i>Albert Albers, Armin Kurrle</i>	
ONTOLOGICAL FOUNDATIONS FOR FEATURE-BASED MODELING	174
<i>Emilio M. Sanfilippo</i>	

SESSION B2 – DESIGN FOR X

INTEGRATED PRODUCT, PRODUCTION AND MATERIAL DEFINITION FOR CONVENTIONAL VERSUS GENERATIVE MANUFACTURING TECHNOLOGIES	180
<i>Jerome Kaspar, Pascal Stoffels, Jan-Henrik Schneberger, Michael Vielhaber</i>	
DESIGN FOR PM CHALLENGES AND OPPORTUNITIES FOR POWDER METAL COMPONENTS IN TRANSMISSION TECHNOLOGY	186
<i>Tim Frech, Philipp Scholzen, Philipp Schäfflein, Christoph Löpenhaus, P. Kauffmann, Fritz Klocke</i>	
CASE STUDY: APPLICATION OF DESIGN FOR AUTOMATED ASSEMBLY METHODS IN THE DEVELOPMENT OF AN ELECTRONIC PRODUCT FROM EARLY DESIGN TO DESIGN FREEZE	192
<i>Olivier Roulet-Dubonnet, Rune Kringstad Sandøy, Kjersti Øverbø Schulte</i>	
PSS DESIGN THROUGH DESIGN FOR SUPPLY CHAIN: STATE OF THE ART REVIEW	198
<i>Oyetola Emmanuel Ebikake, Claudio Sassanelli, Sergio Terzi</i>	

SESSION B3 – FOR A SUSTAINABLE WORLD

SELECTION METHOD FOR MULTIPLE PERFORMANCES EVALUATION DURING EARLY DESIGN STAGES	204
<i>Kévin Audoux, Frédéric Segonds, Olivier Kerbrat, Améziane Aoussat</i>	
EVALUATING COLLABORATION PRODUCTIVITY IN INTERDISCIPLINARY PRODUCT DEVELOPMENT	211
<i>Guenther Schuh, Michael Riesener, Christian Mattern, Maria Linnartz, Felix Basse</i>	
INTEGRATION OF AN ASSESSMENT METHODOLOGY FOR THE SELECTION OF JOINING TECHNOLOGIES IN LIGHTWEIGHT ENGINEERING	217
<i>Saphir A. Choudry, Jerome Kaspar, Uwe Alber, Dirk Landgrebe</i>	
AN APPROACH TO IDENTIFY THE FACTORS THAT AFFECT A PRODUCTS LIFE TIME ENERGY CONSUMPTION DURING THE CONCEPT DESIGN STAGE	223
<i>S M Ibbotson, S Kara</i>	
A DESIGN TO ENVIRONMENT MODELLING APPROACH BASED ON TIME VARIATION NETWORKS	229
<i>Maud Rio, Andreas Riel, Shinsuke Kondoh</i>	

SESSION B4 – CREATIVITY, INNOVATION AND HUMAN BIO-INSPIRED ISSUES

STUDY FOR DEVELOPMENT OF A PATIENT-SPECIFIC 3D PRINTED CRANIOFACIAL MEDICAL DEVICE: DESIGN BASED ON 3D VIRTUAL BIOMODELS/ CAD/ RP	235
<i>Cristian C. Ardila, Clara Isabel López, Javier Mauricio Martínez, Gemy Liliana Meléndez, D. Navarro, Carlos Fernando Galeano</i>	
MEANINGFUL PREDICTION PARAMETERS FOR EVALUATING THE SUITABILITY OF POWER TOOLS FOR USAGE	241
<i>Sven Mathiesen, René Germann</i>	
COEVOLUTIONARY AND SYMBIOTIC RELATIONSHIPS IN DESIGN, MANUFACTURING AND ENTERPRISE	247
<i>A. C. Penn, Ang Liu</i>	
PRODUCT PROFILES: MODELLING CUSTOMER BENEFITS AS A FOUNDATION TO BRING INVENTIONS TO INNOVATIONS	253
<i>Albert Albers, Jonas Heimicke, Benjamin Walter, Gustav Nils Basedow, N. Reiß, N. Heitger, S. Ott, Nikola Bursac</i>	
A COMPARISON BETWEEN THE FUNCTIONAL ANALYSIS AND THE CAUSAL-LOOP DIAGRAM TO MODEL INVENTIVE PROBLEMS	259
<i>Jesús Delgado-Maciel, Guillermo Cortés-Robles, Giner Alor-Hernández, Jorge García Alcaráz, Stéphane Negny</i>	
DIVERGENT PROTOTYPING EFFECT ON THE FINAL DESIGN SOLUTION: THE ROLE OF "DARK HORSE" PROTOTYPE IN INNOVATION PROJECTS	265
<i>Luiz Fernando C. S. Durão, Kevin Kelly, Davi N. Nakano, Eduardo Zancul, Conor L. McGinn</i>	
HOW TO EVALUATE THE POSTURAL BALANCE IN A MORE EFFICIENT AND LESS EXPENSIVE WAY?	272
<i>Cuarrelli Gilberto, Di Donato Alain, Misset Julia, Gomes Lisboa De Souza Adriana, M. Reisa, C. Vania, J. Tomazini, G. Thomann, Thomann Guillaume</i>	
MECHANICAL DESIGN OF A STANDING FRAME ADAPTED FOR CHILDREN WITH MENTAL DEFICIENCY	278
<i>Mariana Laranjeira, Sônia Alves, Telma Dantas, Virgínia Barbosa, J. Machado, L. Varela, P. Avila, Goran Putnik</i>	

SESSION B5 – ROBOTICS INTEGRATION

EXPERIMENTAL STUDY OF THE PHYSICAL IMPACT OF A PASSIVE EXOSKELETON ON MANUAL SANDING OPERATIONS	284
<i>Aurélie Moyon, Emilie Poirson, Jean-François Petiot</i>	
DESIGN OF A CABLE-DRIVEN PARALLEL ROBOT WITH GRASPING DEVICE	290
<i>Antoine Martin, Stéphane Caro, Philippe Cardou</i>	
PARASITIC INCLINATIONS IN CABLE-DRIVEN PARALLEL ROBOTS USING CABLE LOOPS	296
<i>Saman Lessanibahri, Philippe Cardou, Stéphane Caro</i>	
DEVELOPMENT OF A LOW-COST PORTABLE POCT DEVICE BASED ON ARM	302
<i>Xiaodong Xing, Xiangting Huang, Ying Jin, Liquan Wang</i>	
MECHANICAL DESIGN OPTIMIZATION OF A PIPING INSPECTION ROBOT	307
<i>Damien Chablat, Swaminath Venkateswaran, Frédéric Boyer</i>	

SESSION C1 – DESIGN & EDUCATION

TRANSDISCIPLINARY DESIGN EDUCATION FOR ENGINEERING UNDERGRADUATES: MAPPING OF BLOOM'S TAXONOMY COGNITIVE DOMAIN ACROSS DESIGN STAGES	313
<i>Alyona Sharunova, Mehwish Butt, Ahmed Jawad Qureshi</i>	
FROM ENGINEERING TO INDUSTRIAL DESIGN: ISSUES OF EDUCATING FUTURE ENGINEERS TO SYSTEMIC DESIGN	319
<i>Lucile Trevisan, Pier Paolo Peruccio, Silvia Barbero</i>	
CDIO DESIGN EDUCATION COLLABORATION USING 3D-DESKTOP PRINTERS	325
<i>Thomas Haavi, Nina Tvenge, Kristian Martinsen</i>	
DESIGN AND INNOVATION LEARNING: CASE STUDY IN NORTH AFRICAN ENGINEERING UNIVERSITIES USING CREATIVITY WORKSHOPS AND FABRICATION LABORATORIES	331
<i>Helmi Ben Rejeb, Benoît Roussel</i>	
TRANSDISCIPLINARY ENGINEERING DESIGN EDUCATION: ONTOLOGY FOR A GENERIC PRODUCT DESIGN PROCESS	338
<i>Mehwish Butt, Alyona Sharunova, Mario Storga, Yasir Imtiaz Khan, Ahmed Jawad Qureshi</i>	
DISTRIBUTED PRODUCT DESIGN IN EDUCATIONAL PROGRAMS	344
<i>Carina Fresemann, Rainer Stark, Roy Damgrave, Nathalie Bekkering, Eric Lutters</i>	

SESSION C2 – AUGMENTED REALITY

DESIGNING AN AR INTERFACE TO IMPROVE TRUST IN HUMAN-ROBOTS COLLABORATION	350
<i>Riccardo Palmarini, Iñigo Fernandez Del Amo, Guglielmo Bertolino, Gino Dini, J. Erkoyuncu, R. Roy, Michael Farnsworth</i>	
THE RATIONALE OF PSS AS AN INSPIRATION FOR SYNTHETIC ENVIRONMENTS	356
<i>R. G. J. Damgrave, E. Lutters</i>	
AN INNOVATIVE USER-CENTRED SUPPORT TOOL FOR AUGMENTED REALITY MAINTENANCE SYSTEMS DESIGN: A PRELIMINARY STUDY	362
<i>Iñigo Fernández Del Amo, Elisa Galeotti, Riccardo Palmarini, Gino Dini, J. Erkoyuncu, Rajkumar Roy</i>	
AUGMENTED REALITY BASED VISUALIZATION OF CAM INSTRUCTIONS TOWARDS INDUSTRY 4.0 PARADIGM: A CNC BENDING MACHINE CASE STUDY	368
<i>Dimitris Mourtzis, Vasilios Zogopoulos, Ioannis Katagis, Panagiotis Lagios</i>	

SESSION C3 – CUSTOMIZATION & MODULARIZATION

DESIGN FOR RECONFIGURATION AS FUNDAMENTAL ASPECT OF SMART PRODUCTS	374
<i>Philipp Savarino, Michael Abramovici, Jens Christian Göbel, Philip Gebus</i>	
TOWARDS A DECISION-MAKING FRAMEWORK FOR MULTI-CRITERIA PRODUCT MODULARIZATION IN COOPERATIVE ENVIRONMENTS	380
<i>Marc Windheim, Nicolas Gebhardt, Dieter Krause</i>	
IDENTIFICATION OF THE COST-BENEFIT-OPTIMAL PRODUCT CONFIGURATION	386
<i>Guenther Schuh, Christian Doelle, Jan Koch, Pascal Grutza</i>	
OBOLESCENCE PREDICTION: A BAYESIAN MODEL	392
<i>Marc Zolghadri, Sid-Ali Addouche, Kevin Boissie, Daniel Richard</i>	
A TRAINING FRAMEWORK FOR THE SYNTHESIS OF A CONSISTENT SYSTEM OF OBJECTIVES IN MODULAR DESIGN	398
<i>Thilo Richter, Albert Albers, Clemens Birk, Michael Rapp, Nikola Bursac</i>	
DESIGN AUTOMATION OF CONTROL PANELS FOR AUTOMATED MODULAR CONSTRUCTION MACHINES	404
<i>Edgar C. Tamayo, Yasir Imtiaz Khan, Ahmed Jawad Qureshi, Mohamed Al-Hussein</i>	

SESSION C4 – LIFE-CYCLE INFORMATION & SYSTEM

A REQUIREMENT MINING FRAMEWORK TO SUPPORT COMPLEX SUB-SYSTEMS SUPPLIERS	410
<i>Romain Pinqu�, Philippe V�ron, Fr�d�ric Segonds, Nicolas Crou�</i>	
A FRAMEWORK FOR OPTIMAL DESIGN OF COMPLEX PRODUCTS	416
<i>Deyi Xue, David Imaniyan</i>	

LEAN OR ERP – A DECISION SUPPORT SYSTEM TO SATISFY BUSINESS OBJECTIVES	422
<i>Saraswati Jituri, Brian Fleck, Rafiq Ahmad</i>	
TOWARDS AN UNIFIED ADDITIVE MANUFACTURING PRODUCT-PROCESS MODEL FOR DIGITAL CHAIN MANAGEMENT PURPOSE	428
<i>Farouk Belkadi, Laura Martinez Vidal, Alain Bernard, Eujin Pei, Emilio M. Sanfilippo</i>	
SYNERGY EFFECTS BY USING SYSML MODELS FOR THE LIGHTWEIGHT DESIGN METHOD “EXTENDED TARGET WEIGHING APPROACH”	434
<i>Albert Albers, Georg Moeser, Sven Revfi</i>	
A LINKED DATA APPROACH FOR THE CONNECTION OF MANUFACTURING PROCESSES WITH PRODUCTION SIMULATION MODELS	440
<i>Richard Senington, Fabian Baumeister, Amos Ng, Jan Oscarsson</i>	
A SYSTEMS APPROACH FOR THE DEFINITION OF LEAN WORKFLOWS IN GLOBAL AEROSPACE MANUFACTURING COMPANIES	446
<i>Jaime Rojo Abollado, Essam Shehab</i>	
A FRAMEWORK METHOD OF USER-PARTICIPATION CONFIGURATION DESIGN FOR COMPLEX PRODUCTS	451
<i>Jing Li, Yafei Nie, Xinwei Zhang, Keqin Wang, S. Tong, Benoit Eynard</i>	

SESSION C5 – DESIGN THEORY

COPING WITH COMPLEX SYSTEMS-OF-SYSTEMS IN THE CONTEXT OF PGE – PRODUCT GENERATION ENGINEERING	457
<i>Albert Albers, Natalie Peglow, Jonas Powelske, Clemens Birk, Nikola Bursac</i>	
A SURROGATE MODEL BASED ON NON-UNIFORM RATIONAL B-SPLINES HYPERSURFACES	463
<i>Y. Audoux, M. Montemurro, J. Pailhes</i>	
REFERENCE PRODUCTS IN PGE – PRODUCT GENERATION ENGINEERING: ANALYZING CHALLENGES BASED ON THE SYSTEM HIERARCHY	469
<i>Albert Albers, Simon Rapp, Nicolas Heitger, Friedrich Wattenberg, Nikola Bursac</i>	
FROM REALITY TO SIMULATION – USING THE C&C2-APPROACH TO SUPPORT THE MODELLING OF A DYNAMIC SYSTEM	475
<i>Sven Matthiesen, Patric Grauberger, Carolin Sturm, Michael Steck</i>	
INTEGRATED CROSS-COMPONENT LIGHTWEIGHT AND MATERIAL-ORIENTED DEVELOPMENT METHODOLOGY – THE EMBODIMENT DESIGN CYCLE	481
<i>Jerome Kaspar, Michael Vielhaber</i>	
Author Index	