

54th CIRP Conference on Manufacturing Systems (54th CIRP CMS 2021)

"Towards Digitalized Manufacturing 4.0"

Procedia CIRP Volume 104

Patras, Greece
22 – 24 September 2021

Part 1 of 3

Editor:

Dimitris Mourtzis

ISBN: 978-1-7138-4161-6

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© (2021) The Authors. Published by Elsevier Ltd.
Creative Commons Attribution 4.0 International License.
License details: <http://creativecommons.org/licenses/by/4.0/>.

No changes have been made to the content of these proceedings. There may be changes to pagination, and minor adjustments for aesthetics.

Printed with permission by Curran Associates, Inc. (2022)

For permission requests, please contact the publisher:

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

EDITORIAL.....	1
<i>D. Mourtzis</i>	
MODULARIZATION ACROSS MANAGERIAL LEVELS AND BUSINESS DOMAINS: LITERATURE REVIEW & RESEARCH DIRECTIONS.....	3
<i>Morten Skogstad Nielsen, Ann-Louise Andersen, Thomas Ditlev Brunoe, Kjeld Nielsen</i>	
SIMULATION OF ORDER PROCESSING IN GLOBAL PRODUCTION NETWORKS	8
<i>Michael Milde, Fabian Sippl, Gunther Reinhart</i>	
DEVELOPMENT OF MEASURING SYSTEMS FOR CONTACT FORCE AND RELATIVE VELOCITY IN ROBOT-GUIDED CENTRIFUGAL FINISHING	14
<i>Marius Ohlert, Tim Schriever, Sebastian Prinz, Sebastian Barth, Thomas Bergs</i>	
RETRIEVING PROPERTIES OF MANUFACTURING SYSTEMS FROM TRACEABILITY DATA FOR PERFORMANCE EVALUATION AND MATERIAL FLOW SIMULATION	20
<i>Heiner Reinhardt, Marc Münnich, Bastian Prell, Roman Arnold, Matthias Putz</i>	
REAL-TIME PERSONALIZED DRIVER SUPPORT SYSTEM FOR PILOT ASSIST PROMOTION IN DIFFERENT TRAFFIC CONDITIONS	26
<i>Julia Orlovska, Casper Wickman, Rikard Söderberg</i>	
IDENTIFICATION AND SYSTEMATIZATION OF STRATEGIC TECHNOLOGY DEMANDS IN MANUFACTURING.....	32
<i>Quirin Gärtner, Andreas Hofer, Gunther Reinhart</i>	
EVALUATION OF A DIGITAL WORKER ASSISTANCE SYSTEM TO ENABLE ADAPTIVE TASK SHARING BETWEEN HUMANS AND COBOTS IN MANUFACTURING	38
<i>Christina Schmidbauer, Bernd Hader, Sebastian Schlund</i>	
SIMULATION OF FRICTION BETWEEN DIAMOND AND POLYCRYSTALLINE CUBIC BORON NITRIDE	44
<i>Ulrich Müller, Sebastian Prinz, Sebastian Barth, Thomas Bergs</i>	
BENCHMARKING OF DATA PREPROCESSING METHODS FOR MACHINE LEARNING- APPLICATIONS IN PRODUCTION.....	50
<i>Maik Frye, Johannes Mohren, Robert H. Schmitt</i>	
PLANT TECHNOLOGY FOR THE INDUSTRIAL COATING PROCESS FOR SULFIDE- BASED ALL-SOLID-STATE BATTERIES	56
<i>Célestine Singer, Hans-Christoph Töpfer, Florian J. Günter, Gunther Reinhart</i>	
TOWARDS DATA ACQUISITION FOR PREDICTIVE MAINTENANCE OF INDUSTRIAL ROBOTS	62
<i>Corbinian Nentwich, Gunther Reinhart</i>	
A NOVEL APPROACH TO GENERATE AUGMENTED REALITY ASSEMBLY ASSISTANCE AUTOMATICALLY FROM CAD MODELS.....	68
<i>Alexander Neb, David Brandt, Greg Rauhöft, Ramez Awad, Thomas Bauernhansl</i>	

USABILITY STUDY OF A USER-FRIENDLY AR ASSEMBLY ASSISTANCE.....	74
<i>Alexander Neb, David Brandt, Ramez Awad, Silvana Heckelsmüller, Thomas Bauernhansl</i>	
PREDICTIVE MAINTENANCE KEY CONTROL PARAMETERS FOR ACHIEVING EFFICIENT ZERO DEFECT MANUFACTURING.....	80
<i>Foivos Psarommatis, Gokan May, Dimitris Kiritsis</i>	
SPATIALLY RESOLVED TOOL WEAR PREDICTION IN FINISH MILLING.....	85
<i>Carsten Holst, Michael Königs, Eduardo Maia Garcia, Philipp Ganser, Thomas Bergs</i>	
DEM SIMULATIONS OF THE CALENDERING PROCESS: PARAMETERIZATION OF THE ELECTRODE MATERIAL OF LITHIUM-ION BATTERIES.....	91
<i>David Schreiner, Johannes Lindenblatt, Florian J. Günter, Gunther Reinhart</i>	
CONTINUOUS ADAPTION THROUGH REAL DATA ANALYSIS TURN SIMULATION MODELS INTO DIGITAL TWINS.....	98
<i>Leonard Overbeck, Oliver Brützel, Michael Teufel, Nicole Stricker, Gisela Lanza</i>	
QUANTIFICATION OF INFLUENCE OF 5G TECHNOLOGY IMPLEMENTATION ON PROCESS PERFORMANCE IN PRODUCTION.....	104
<i>Raphael Kiesel, Kirstin Stichling, Philipp Hemmers, Thomas Vollmer, Robert H. Schmitt</i>	
ADDRESSING INFORMATION ASYMMETRY DURING DESIGN: CUSTOMER-CENTRIC APPROACH TO HARMONIZATION OF CAR BODY SPLIT-LINES.....	110
<i>Kostas Stylidis, Monica Rossi, Jonas Žukas, Rikard Söderberg</i>	
PRELIMINARY STUDY ON PERCEIVED COMFORT OF CAR SEATS: A QUANTITATIVE APPROACH TO VISUAL CUES.....	116
<i>Bastian Quattelbaum, Kostas Stylidis, Alina Braun, Rikard Söderberg</i>	
IDENTIFICATION OF WELD GEOMETRY FROM ULTRASOUND SCAN DATA USING DEEP LEARNING.....	122
<i>Etienne Provencal, Luc Laperrière</i>	
DECISION APPROACH FOR THE DESIGN AND SENSOR INTEGRATION OF AN LPBF MANUFACTURED GRIPPER END EFFECTOR.....	128
<i>Günther Schuh, Georg Bergweiler, Martin Zäpfel, Anurag Salian, Philipp Bickendorf</i>	
LINEAR OPTIMIZATION FOR DYNAMIC SELECTION OF RESOURCES IN CONSTRAINED ASSEMBLY LINE BALANCING PROBLEMS.....	134
<i>Marcel Albus, Carsten Seeber</i>	
ADAPTING AUGMENTED REALITY SYSTEMS TO THE USERS' NEEDS USING GAMIFICATION AND ERROR SOLVING METHODS.....	140
<i>Jessica Ulmer, Sebastian Braun, Chi-Tsun Cheng, Steve Dowey, Jörg Wollert</i>	
IN-SITU DEFECT DETECTION AND MONITORING FOR LASER POWDER BED FUSION USING A MULTI-SENSOR BUILD PLATFORM.....	146
<i>Clemens Maucher, Kim Torben Werkle, Hans-Christian Möhring</i>	
HOW DISTRIBUTED LEDGER TECHNOLOGIES AFFECT BUSINESS MODELS OF MANUFACTURING COMPANIES.....	152
<i>Johannes Mayer, Philipp Niemietz, Daniel Trauth, Thomas Bergs</i>	
EXPLORING THE CONCEPT OF PRODUCTION PLATFORMS - A LITERATURE REVIEW.....	158
<i>Simon Boldt, Gary Linnéusson, Carin Rösiö</i>	

WEAR MONITORING IN FINE BLANKING PROCESSES USING FEATURE BASED ANALYSIS OF ACOUSTIC EMISSION SIGNALS	164
<i>Martin Unterberg, Herman Voigts, Ingo Felix Weiser, Andreas Feuerhack, Thomas Bergs</i>	
EVALUATION OF THE INFLUENCE OF CHANGE DRIVERS ON THE FACTORY LIFE CYCLE.....	170
<i>Lennart Hingst, Antal Dér, Christoph Herrmann, Peter Nyhuis</i>	
TIME- AND COST-EFFICIENT SPECIFICATION AND EVALUATION OF MANUFACTURING CHANGES THROUGH ITERATIVE INFORMATION ACQUISITION.....	176
<i>L. Hermann, A. Weber, A. Beckers, S. Barth, T. Bergs</i>	
ENERGY ANOMALY DETECTION IN INDUSTRIAL APPLICATIONS WITH LONG SHORT-TERM MEMORY-BASED AUTOENCODERS.....	182
<i>Can Kaymakci, Simon Wenninger, Alexander Sauer</i>	
SMART MANUFACTURING AS A FRAMEWORK FOR SMART MINING	188
<i>Vidosav Majstorovic, Vladimir Simeunovic, Zarko Miskovic, Radivoje Mitrovic, Sonja Dimitrijevic</i>	
ONTOLOGY-BASED DATA MANAGEMENT FOR ADAPTABLE SAFETY FUNCTIONS IN CYBER-PHYSICAL PRODUCTION SYSTEMS	194
<i>Christian Brecher, Melanie Buchsbaum, Frances Ziegler, Simon Storms</i>	
NEGOTIATION BASED APPROACH FOR COLLECTING AND RECYCLING OPERATIONS IN CIRCULAR ECONOMY.....	200
<i>Giuseppe Stecca, Toshiya Kaihara</i>	
LEVERAGING MULTIMODAL DATA FOR INTUITIVE ROBOT CONTROL TOWARDS HUMAN-ROBOT COLLABORATIVE ASSEMBLY.....	206
<i>Sichao Liu, Lihui Wang, Xi Vicent Wang, Clayton Cooper, Robert X. Gao</i>	
STARTING POINTS FOR DIGITAL SHOP FLOOR MANAGEMENT IN PRODUCTION ENTERPRISES	212
<i>Alyssa Meissner, David Scherer, Joachim Metternich</i>	
INTELLIGENT ENERGY SYSTEMS AS ENABLER FOR INCREASED RESILIENCE OF MANUFACTURING SYSTEMS	217
<i>Dennis Bauer, Can Kaymakci, Thomas Bauernhansl, Alexander Sauer</i>	
TECHNICAL AND DIGITAL TWIN CONCEPT OF AN INDUSTRIAL HEAT TRANSFER STATION FOR LOW EXERGY WASTE HEAT.....	223
<i>Thomas Kohne, Max Burkhardt, Lukas Theisinger, Matthias Weigold</i>	
DESIGN METHOD FOR BUILDING AUTOMATION CONTROL PROGRAMS TO ENABLE THE ENERGETIC OPTIMIZATION OF INDUSTRIAL SUPPLY SYSTEMS	229
<i>Daniel Fuhrländer-Völker, Martin Lindner, Matthias Weigold</i>	
5G AS AN ENABLER FOR CLOUD-BASED MACHINE TOOL CONTROL	235
<i>Carina Siedler, Jan Mertes, Li Yi, Moritz Glatt, Jan C. Aurich</i>	
MATURITY-BASED DEVELOPMENT OF STRATEGIC THRUSTS FOR SOCIO-TECHNICAL RISKS.....	241
<i>Joern Steffen Menzefricke, Ingrid Wiederkehr, Christian Koldewey, Roman Dumitrescu</i>	

A FRAMEWORK FOR DATA-BASED CHANGE IMPACT ANALYSIS IN MANUFACTURING	247
<i>Fabian Sippl, Gunther Reinhart</i>	
EVALUATION MODEL FOR COOPERATIVE INVENTORY POOLING-SYSTEMS	253
<i>Yannic Hafner, Julius Bock, Christofer Keppler, Johannes Fottner</i>	
LEAN PRODUCTION SYSTEMS 4.0: THE IMPACT OF THE DIGITAL TRANSFORMATION ON PRODUCTION SYSTEM LEVELS	259
<i>Simon Schumacher, Felix Aljoscha Schmid, Andreas Bildstein, Thomas Bauernhansl</i>	
MACHINE LEARNING BASED DEFECT DETECTION IN A LOW AUTOMATED ASSEMBLY ENVIRONMENT	265
<i>G. Schuh, A. Gützloff, K. Thomas, M. Welsing</i>	
A BIG DATA APPROACH FOR WORKER'S PERFORMANCE EVALUATION IN IOT- ENABLED MANUFACTURING SHOPFLOORS	271
<i>Ng Chi Sang, Yee Wai Lok, Ray Y. Zhong</i>	
WORK CENTER PERFORMANCE MEASUREMENT BASED ON MULTIPLE TIME SERIES	276
<i>Roman Ungern-Sternberg, Christoph Leipoldt, Klaus Erlach</i>	
TOWARDS SUSTAINABLE SERVICITIZATION: A LITERATURE REVIEW OF METHODS AND FRAMEWORKS	283
<i>Clarissa A. González Chávez, Maria Holgado, Anna Öhrwall Rönnbäck, Mélanie Despeisse, Björn Johansson</i>	
SUPPLY RISK EXPOSURE MEASUREMENT IN MANUFACTURING SUPPLY NETWORKS: AN INDEX CONSTRUCTION APPROACH	289
<i>Marc Wiedenmann, Andreas Größler</i>	
METHOD FOR THE ECONOMIC EVALUATION OF WASTE HEAT RECOVERY TECHNOLOGIES IN BIVALENT FACILITIES	295
<i>Ekrem Köse, Lukas Willer, Alexander Sauer</i>	
LASER ABLATION ADAPTIVE SLICING FOR SHAPE DEVIATION CONTROL OF ADDITIVELY MANUFACTURED PARTS	301
<i>Oliver Avram, Marco Menerini, Anneke Orlandini, Anna Valente, Emanuele Carpanzano</i>	
AUTOMATED ONE-OFF PRODUCTION IN WOODWORKING BY PART-TO-TOOL	307
<i>Marten Stepputat, Florian Beuss, Uwe Pfletscher, Jan Sender, Wilko Fluegge</i>	
RESILIENCE-ENHANCING WORKPLACE DESIGN - AN APPROACH FOR WORKPLACES IN THE MANUAL ASSEMBLY OF LARGE-SCALED ONE-OFF PRODUCTS	313
<i>Florian Beuss, Jan Sender, Wilko Fluegge</i>	
DIGITAL THREAD IN SHIPBUILDING AS A PREREQUISITE FOR THE DIGITAL TWIN	318
<i>Konrad Jagusch, Jan Sender, David Jericho, Wilko Flügge</i>	
EUPROGIGANT – A CONCEPT TOWARDS AN INDUSTRIAL SYSTEM ARCHITECTURE FOR DATA-DRIVEN PRODUCTION SYSTEMS	324
<i>Stefan Dumss, Markus Weber, Clemens Schwaiger, Clemens Sulz, Matthias Weigold</i>	
CONCEPT FOR THE DEVELOPMENT OF A LEAN 4.0 REFERENCE IMPLEMENTATION STRATEGY FOR MANUFACTURING COMPANIES	330
<i>Fabian Dillinger, Moritz Kagerer, Gunther Reinhart</i>	

AN ARCHITECTURE FOR SIM-TO-REAL AND REAL-TO-SIM EXPERIMENTATION IN ROBOTIC SYSTEMS.....	336
<i>Rok Vrabic, Gašper Škulj, Andreja Malus, Dominik Kozjek, Primož Podržaj</i>	
THE PRODUCTIVITY IMPACT OF THE DIGITALLY CONNECTED 5 – LAYER STACK IN MANUFACTURING ENTERPRISES	342
<i>Adolfo Crespo Del Castillo, John Patsavellas, Konstantinos Salonitis, Christos Emmanouilidis</i>	
USE OF VIRTUAL SUPPLY CHAIN CONSTRUCTED BY CYBER-PHYSICAL SYSTEMS CONCEPT.....	351
<i>Michiko Matsuda, Tatsushi Nishi, Ryuichi Kamiebisu, Mao Hasegawa, Ziang Liu</i>	
MACHINE LEARNING BASED IDENTIFICATION OF ENERGY STATES OF METAL CUTTING MACHINE TOOLS USING LOAD PROFILES.....	357
<i>Lars Petruschke, Jessica Walther, Max Burkhardt, Max Luther, Matthias Weigold</i>	
DYNAMIC DATA ACQUISITION AND PREPROCESSING FOR AUTOMATIC BEHAVIORAL MODELING OF CYBER-PHYSICAL SYSTEMS	363
<i>Brandon K. Sai, Yannick T. Mayer, Thomas Bauernhansl</i>	
A DIGITAL TWIN-BASED FRAME WORK FOR TASK PLANNING AND ROBOT PROGRAMMING IN HRC	370
<i>Weibo Ren, Xiaonan Yang, Yan Yan, Yaoguang Hu, Lixiang Zhang</i>	
TURNING PROCESS MONITORING WITH DEEP NEURAL NETWORK TRAINED BY FEM SIMULATION	376
<i>Takashi Misaka, Jonny Herwan, Ichiro Ogura, Yoshiyuki Furukawa</i>	
A DYNAMIC SCHEDULING METHOD FOR SELF-ORGANIZED AGVS IN PRODUCTION LOGISTICS SYSTEMS.....	381
<i>Lixiang Zhang, Yan Yan, Yaoguang Hu, Weibo Ren</i>	
A METHOD OF CONSTRUCTING THE MAINTENANCE SERVICE NETWORK UNDER THE REDISTRICTING AND SERVICE PROVIDER DEMAND SHARING	387
<i>Xiaoyang Zhen, Jingqian Wen, Yipu Yao, Yaoguang Hu</i>	
A LOCATION-ALLOCATION MODEL OF MAINTENANCE RESOURCES BASED ON FAULT DISTRIBUTION FOR AGRICULTURAL MACHINERY MAINTENANCE SERVICE NETWORK.....	393
<i>Yipu Yao, Jingqian Wen, Xiaoyang Zhen, Yaoguang Hu</i>	
TOOLS, APPLICATION AREAS AND CHALLENGES OF FACTORY SIMULATION IN SMALL AND MEDIUM-SIZED ENTERPRISES – A REVIEW.....	399
<i>Fei Yu, Chen Zheng</i>	
ADAPTIVE SPATIAL AUGMENTED REALITY FOR INDUSTRIAL SITE ASSEMBLY.....	405
<i>Patrick Rupprecht, Hans Kueffner-McCauley, Majesa Trimmel, Sebastian Schlund</i>	
EVOLVING DISPATCHING RULES USING GENETIC PROGRAMMING FOR MULTI-OBJECTIVE DYNAMIC JOB SHOP SCHEDULING WITH MACHINE BREAKDOWNS	411
<i>Salama Shady, Toshiya Kaihara, Nobutada Fujii, Daisuke Kokuryo</i>	
A REAL-WORLD APPLICATION OF PROCESS MINING FOR DATA-DRIVEN ANALYSIS OF MULTI-LEVEL INTERLINKED MANUFACTURING PROCESSES	417
<i>Alexander Birk, Yannick Wilhelm, Simon Dreher, Christian Flack, Christoph Gröger</i>	

DOUBLE-STAGE METHODOLOGY FOR ACTIVITY RECOGNITION IN MANUAL ASSEMBLY.....	423
<i>Joachim P. Doppler, Lisa C. Günther, Christoph Haar</i>	
A SCENARIO-BASED APPROACH FOR TRANSLATING STRATEGIC PERSPECTIVES INTO INPUT VARIABLES FOR PRODUCTION PLANNING AND CONTROL.....	429
<i>Ida Wonsak, Harald Bauer, Fabian Sippl, Gunther Reinhart</i>	
COST-EFFICIENT, TRUE SILICONE PRINTER WITH VARIABLE MATERIAL SPECTRUM FOR INDIVIDUALIZED MEDICAL APPLICATIONS	435
<i>Sina Martin, Lukas Gugel, Thomas Martin, Alexander Preis, Jörg Franke</i>	
OPERATOR-CENTRED LEAN 4.0 FRAMEWORK FOR FLEXIBLE ASSEMBLY LINES	440
<i>Adrian Miqueo, Marta Torralba, José A. Yagüe-Fabra</i>	
CONVOLUTIONAL NEURAL NETWORK WITH DUAL INPUTS FOR TIME SERIES ICE PREDICTION ON ROTOR BLADES OF WIND TURBINES	446
<i>Markus Kreutz, Abderrahim Ait Alla, Kamaloddin Varasteh, Jan-Hendrik Ohlendorf, Klaus-Dieter Thoben</i>	
REGULARIZATION-BASED CONTINUAL LEARNING FOR ANOMALY DETECTION IN DISCRETE MANUFACTURING	452
<i>Benjamin Maschler, Thi Thu Huong Pham, Michael Weyrich</i>	
ARCHITECTURE OF A HUMAN-DIGITAL TWIN AS COMMON INTERFACE FOR OPERATOR 4.0 APPLICATIONS.....	458
<i>Andreas Löcklin, Tobias Jung, Nasser Jazdi, Tamás Ruppert, Michael Weyrich</i>	
IMPLICATIONS OF VIRTUAL REALITY ON ENVIRONMENTAL SUSTAINABILITY IN MANUFACTURING INDUSTRY: A CASE STUDY.....	464
<i>Xiaoxia Chen, Liang Gong, Anton Berce, Björn Johansson, Mélanie Despeisse</i>	
DATA-BASED SUPPLY CHAIN COLLABORATION – IMPROVING PRODUCT QUALITY IN GLOBAL PRODUCTION NETWORKS BY SHARING INFORMATION	470
<i>Rainer Silbernagel, Christian Wagner, Alexander Albers, Thies-Uwe Trapp, Gisela Lanza</i>	
VIRTUAL SINGLE FLANK TESTING – APPLICATIONS FOR INDUSTRY 4.0.....	476
<i>M. Willecke, J. Brimmers, C. Brecher</i>	
INTEGRATION OF CYBER-PHYSICAL HVAC SYSTEMS IN INCREMENTAL MANUFACTURING TO IMPROVE ENERGY EFFICIENCY AND AIR QUALITY	482
<i>Marcus Vogt, Jan Schlichter, Franziska Aschersleben, Tim Abraham, Christoph Herrmann</i>	
ANALYTICAL JOINING MODELS FOR LEARNING CONTACT-RICH CABINET ASSEMBLY TASKS FROM SIMULATION	488
<i>Arik Lämmle, Philipp Rusch, Wilhelm Rust, Matthias Senneka, Ramez Awad</i>	
DATA DRIVEN JOINING MODELS FOR SIMULATION-BASED ASSEMBLY LEARNING.....	494
<i>Arik Lämmle, Jonas Krauß, Ramez Awad</i>	
DYNAMIC MODELING OF ADDITIVE MANUFACTURING PROCESS CHAINS FOR END-USE PART MANUFACTURING	500
<i>Mathias Wiese, Antal Dér, Alexander Leiden, Tim Abraham, Sebastian Thiede</i>	
FLEXAROBOS: A MODERN APPROACH FOR FLEXIBLE AUTOMATION OF MACHINE TOOLS	506
<i>Philipp Blanke, Simon Storms, Christian Brecher, Michael Königs</i>	

STUDY ON THE CONFIGURATION GUIDELINE OF OBJECTIVE FUNCTION FOR ACCELERATION/DECELERATION PARAMETER OPTIMIZATION USING A MACHINE TOOL SIMULATOR	512
<i>Yuji Fukuoka, Rui Fukui, Takehito Yoshida, Akihiko Matsumura, Shin'Ichi Warisawa</i>	
DETECTION OF DEFECTS IN SOLIDIFIED LAYERS WITHIN LASER-BASED POWDER BED FUSION USING ACTIVE THERMOGRAPHY	518
<i>Fabian Herzer, Franswa Abraham, Christoph Tammer, Georg Schlick, Johannes Schilp</i>	
BEHAVIOR OF DECISION FOREST CLASSIFICATION IN DYNAMIC MANUFACTURING SYSTEMS	524
<i>Markus Böhm, Thomas Bauernhansl, Sabina Jeschke</i>	
MULTI-OBJECTIVE OPTIMIZATION OF SPRAYING TRAJECTORY PLANNING FOR LARGE SHIP BLOCKS USING EVOLUTIONARY COMPUTATION	530
<i>Xuemei Liu, Yan Feng, Qingfei Zeng, Xiaocai Hu, Zhen Yang</i>	
AR BASED ASSISTANCE FOR THE TOOL CHANGE OF CYBER-PHYSICAL SYSTEMS	536
<i>Benjamin Röhm, Johannes Olbort, Reiner Anderl</i>	
CONCEPT FOR ENABLING CUSTOMER-ORIENTED DATA ANALYTICS VIA INTEGRATION OF PRODUCTION PROCESS IMPROVEMENT METHODS AND DATA SCIENCE METHODS	542
<i>Friedrich Morlock, Mario Boßlau</i>	
ONTOLOGY-BASED PRODUCTION PLANNING UNDER THE CONSIDERATION OF SYSTEM ROBUSTNESS.....	547
<i>Berend Denkena, Marc-André Dittrich, Gina Vibora Münch</i>	
TOWARDS A MODEL FOR EVALUATING THE INVESTMENT OF RECONFIGURABLE AND PLATFORM-BASED MANUFACTURING CONCEPTS CONSIDERING FOOTPRINT ADAPTABILITY.....	553
<i>Stefan Kjeldgaard, Andreas Leon Jorsal, Vanessa Albrecht, Ann-Louise Andersen, Kjeld Nielsen</i>	
SMART IMAGE INSPECTION USING DEFECT-REMOVING AUTOENCODER	559
<i>Yusuke Hida, Savvas Makariou, Sachio Kobayashi</i>	
BUSINESS MODEL ENGINEERING FOR SMART PRODUCT-SERVICE SYSTEMS	565
<i>Mario Boßlau</i>	
TOOL DEFLECTION COMPENSATION BY DRIVE SIGNAL-BASED FORCE RECONSTRUCTION AND PROCESS CONTROL.....	571
<i>Berend Denkena, Benjamin Bergmann, Dennis Stoppel</i>	
IDENTIFYING VALUE CREATION PATTERNS FOR SMART SERVICES.....	576
<i>Jannik Reinhold, Patrick Ködding, Michel Scholtysik, Christian Koldewey, Roman Dumitrescu</i>	
OPEN SEMANTIC MODELING FOR SMART PRODUCTION SYSTEMS	582
<i>Günter Bitsch, Pascal Senjic</i>	
A REVIEW OF PRODUCTION PLANNING MODELS: EMERGING FEATURES AND LIMITATIONS COMPARED TO PRACTICAL IMPLEMENTATION	588
<i>Melissa Demartini, Flavio Tonelli, Massimo Pacella, Gabriele Papadia</i>	

THE CHANGING ROLE OF SHOP-FLOOR OPERATORS IN ZERO DEFECT MANUFACTURING	594
<i>Eirin Lodgaard, Daryl Powell</i>	
APPROACH TO AN OPTIMIZED PRINTING PATH FOR ADDITIVE MANUFACTURING IN CONSTRUCTION UTILIZING FEM MODELING	600
<i>Lukas Lachmayer, Virama Ekanayaka, André Hürkamp, Annika Raatz</i>	
AN INDUSTRY 4.0 TECHNOLOGY IMPLEMENTATION MODEL FOR ROLLING STOCK MAINTENANCE.....	606
<i>Marius Wippel, Dominik Lucke, Johannes L. Jooste</i>	
A FRAMEWORK TO ESTABLISH AN ASSISTANCE SYSTEM BY USING REALITY TECHNOLOGY IN MAINTENANCE	612
<i>Magdalena Bertele, Dominik Lucke, Johannes L. Jooste</i>	
EVIDENTIAL REASONING BASED DIGITAL TWINS FOR PERFORMANCE OPTIMIZATION OF COMPLEX SYSTEMS.....	618
<i>Ananda Chakraborti, Arttu Heininen, Saara Väänänen, Kari T. Koskinen, Henri Vainio</i>	
LIFE-CYCLE-ASSESSMENT OF CAST STONE MANUFACTURING: A CASE STUDY	624
<i>Devanshu Mudgal, Emanuele Pagone, Rayan A. Alkhunani, Konstantinos Salonitis</i>	
MACHINE VISION AND RADIO-FREQUENCY IDENTIFICATION (RFID) BASED REAL- TIME PART TRACEABILITY IN A LEARNING FACTORY	630
<i>Rishi Kumar, Omkar Patil, Karthik Nath S, Krishan Rohilla, Kuldeep Singh Sangwan</i>	
DATA ACQUISITION AND PREPARATION – ENABLING DATA ANALYTICS PROJECTS WITHIN PRODUCTION.....	636
<i>Christoph Schock, Jonas Dumler, Frank Doepper</i>	
PREDICTIVE ANALYTICS IN QUALITY ASSURANCE FOR ASSEMBLY PROCESSES: LESSONS LEARNED FROM A CASE STUDY AT AN INDUSTRY 4.0 DEMONSTRATION CELL.....	641
<i>Peter Burggräf, Johannes Wagner, Benjamin Heinbach, Fabian Steinberg, Moritz Wolter</i>	
SUPPORTING THE DIGITAL TRANSFORMATION: A LOW-THRESHOLD APPROACH FOR MANUFACTURING RELATED HIGHER EDUCATION AND EMPLOYEE TRAINING	647
<i>Christian Kuhn, Dominik Lucke</i>	
UPSCALING STRATEGIES FOR POLYMER ADDITIVE MANUFACTURING: AN ASSESSMENT FROM ECONOMIC AND ENVIRONMENTAL PERSPECTIVE FOR SLS, MJF AND DLP.....	653
<i>Sebastian Thiede, Mathias Wiese, Christoph Herrmann</i>	

PART 2

INVESTIGATING THE APPLICABILITY OF MODULAR FUNCTION DEPLOYMENT IN THE PROCESS INDUSTRY	659
<i>Rasmus Andersen, Thomas D. Brunoe, Kjeld Nielsen</i>	
RECONFIGURABLE MANUFACTURING DEVELOPMENT: INSIGHTS ON STRATEGIC, TACTICAL, AND OPERATIONAL CHALLENGES	665
<i>Carin Rösiö, Ann-Louise Andersen</i>	

REAL-TIME LOCATING SYSTEMS (RTLs) IN FUTURE FACTORIES: TECHNOLOGY REVIEW, MORPHOLOGY AND APPLICATION POTENTIALS	671
<i>Sebastian Thiede, Brendan Sullivan, Roy Damgrave, Eric Lutters</i>	
SMALL AUTOMATION TECHNOLOGY SOLUTION PROVIDERS: FACILITATORS FOR SUSTAINABLE MANUFACTURING	677
<i>Kerstin Johansen, Anna Öhrwall Rönnbäck</i>	
INDUSTRIAL APPLICATIONS OF ARTIFICIAL INTELLIGENCE: FROM GRAND STORIES OF DIGITAL DISRUPTION TO ACTUAL PROGRESS	683
<i>Albrecht Fritzsche, Philipp Gölzer</i>	
A META-MODEL FOR MODULAR COMPOSITION OF TAILORED HUMAN DIGITAL TWINS IN PRODUCTION	689
<i>Elias Montini, Andrea Bettoni, Michele Ciavotta, Emanuele Carpanzano, Paolo Pedrazzoli</i>	
EXPLORING THE LEARNABILITY OF ASSEMBLY TASKS USING DIGITAL WORK INSTRUCTIONS IN A SMART FACTORY	696
<i>Sebastian Pimminger, Werner Kurschl, Lisa Panholzer, Johannes Schönböck</i>	
PREDICTIVE QUALITY FOR HYPOID GEAR IN DRIVE ASSEMBLY	702
<i>Jimmy Chhor, Stefan Gerdhenrichs, Robert H. Schmitt</i>	
METHODOLOGY FOR THE ASSESSMENT OF POTENTIALS, SELECTION, AND DESIGN OF PREDICTIVE MAINTENANCE SOLUTIONS	708
<i>Sahil-Jai Arora, Christoph Ebbecke, Markus Rabe, Jessica Fisch</i>	
AN ADAPTABLE FRAMEWORK TO PROVIDE AR-BASED WORK INSTRUCTIONS AND ASSEMBLY STATE TRACKING USING AN ISA-95 ONTOLOGY	714
<i>Dorothy Gors, Merwan Birem, Roeland De Geest, Corentin Domken, Maarten Witters</i>	
COMPREHENSIVE MACHINE DATA ACQUISITION THROUGH INTELLIGENT PARAMETER IDENTIFICATION AND ASSIGNMENT	720
<i>Philipp Gönzheimer, Andreas Karle, Lorenz Mohr, Jürgen Fleischer</i>	
INFLUENCE OF PART GEOMETRY AND FEATURE SIZE ON THE RESULTING MICROSTRUCTURE AND MECHANICAL PROPERTIES OF THE CASE HARDENING STEEL 16MNCr5 PROCESSED BY LASER POWDER BED FUSION	726
<i>Matthias Schmitt, Florian Gerstl, Max Boesele, Max Horn, Gunther Reinhart</i>	
AUTOMATIZED GENERATION OF ALTERNATIVES FOR PROCESS MONITORING IN CYBER-PHYSICAL ASSEMBLY SYSTEMS	732
<i>Clemens Gonnermann, Benedikt Zels, Gunther Reinhart</i>	
EFFECT OF HEAT TREATMENT ON RESIDUAL STRESS AND WEAR RESISTANCE OF CX STAINLESS STEEL MANUFACTURED BY SELECTIVE LASER MELTING	738
<i>Cheng Chang, Xingchen Yan, Zhaoyang Deng, Qingkun Chu, Julien Gardan</i>	
CONCEPT FOR MODELLING THE INFLUENCE OF ELECTRODE CORRUGATION AFTER CALENDERING ON STACKING ACCURACY IN BATTERY CELL PRODUCTION	744
<i>Dominik Mayer, Jürgen Fleischer</i>	
ENVIRONMENT MODELING FOR EVALUATING SYSTEM VARIANTS IN MODEL-BASED SYSTEMS ENGINEERING	750
<i>Dustin White, Nada Sahlab, Nasser Jazdi, Michael Weyrich</i>	

OPPORTUNITIES FOR MANAGING INCREMENTAL AND RADICAL INNOVATION IN PRODUCTION	756
<i>Mattias Hedman, Lisa Larsson, Anna Öhrwall Rönnbäck</i>	
A DIGITAL TWIN FRAMEWORK FOR THE SIMULATION AND OPTIMIZATION OF PRODUCTION SYSTEMS	762
<i>Itziar Ricondo, Alain Porto, Miriam Ugarte</i>	
EFFECTS OF DIGITAL TWIN SIMULATION MODELLING ON A FLEXIBLE AND FIXTURELESS PRODUCTION CONCEPT IN AUTOMOTIVE BODY SHOPS	768
<i>Günther Schuh, Georg Bergweiler, Mayur Vasant Chougule, Falko Fiedler</i>	
DEVELOPMENT OF A CONCEPT FOR THE USE OF LOW-TEMPERATURE EMULSION IN DRILLING OF INCONEL 718.....	774
<i>Timo Rinschede, Dirk Biermann, Ivan Iovkov, Milan Bücker</i>	
INFLUENCE OF TEMPERATURE IN FRONT FACE FLOW DRILLING AND THREAD FORMING OF LIGHTWEIGHT CAST ALLOYS	780
<i>Nils Felinks, Yashar Sarafraz, Jannis Saelzer, Frank Walther, Dirk Biermann</i>	
ENHANCING AN INTELLIGENT DIGITAL TWIN WITH A SELF-ORGANIZED RECONFIGURATION MANAGEMENT BASED ON ADAPTIVE PROCESS MODELS	786
<i>Timo Müller, Benjamin Lindemann, Tobias Jung, Nasser Jazdi, Michael Weyrich</i>	
SCOPE AND DELIMITATION OF GAME ENGINE SIMULATIONS FOR ULTRA-FLEXIBLE PRODUCTION ENVIRONMENTS	792
<i>Liliana Zarco, Jörg Siegert, Thilo Schlegel, Thomas Bauernhansl</i>	
LONG-TERM CYCLE-TESTS OF AN ADDITIVELY MANUFACTURED SOFT RING-GRIPPER	798
<i>Florian Schreiber, Martin Manns</i>	
EXPLORING DIGITAL INNOVATION IN THE PRODUCTION PROCESS: A SUGGESTED FRAMEWORK FOR AUTOMATION TECHNOLOGY SOLUTION PROVIDERS	803
<i>Hossein Rahnama, Kerstin Johansen, Lisa Larsson, Anna Öhrwall Rönnbäck</i>	
ADAPTIVE VISUAL CONCEPT FOR CONTROLLING CYBER-PHYSICAL PRODUCTION MODULES BASED ON COGNITIVE ASSOCIATIONS.....	809
<i>Jörg Siegert, Liliana Zarco, Thilo Schlegel</i>	
AN APPROACH FOR AN INTEGRATED MAINTENANCE STRATEGY SELECTION CONSIDERING THE CONTEXT OF THE VALUE-ADDING NETWORK.....	815
<i>Lennard Sielaff, Dominik Lucke</i>	
ADAPTIVE, PREDICTIVE MACHINE CONDITION ASSESSMENT FOR RESILIENT DIGITAL SOLUTIONS.....	821
<i>Manja Mai-Ly Pfaff, Felix Dörrer, Uwe Friess, Michael Praedicow, Matthias Putz</i>	
VISION-BASED DAMAGE LOCALIZATION METHOD FOR AN AUTONOMOUS ROBOTIC LASER CLADDING PROCESS	827
<i>Habiba Zahir Imam, Yufan Zheng, Pablo Martinez, Rafiq Ahmad</i>	
AN ECOSYSTEM FOR DIGITAL SHADOWS IN MANUFACTURING	833
<i>Christian Brecher, Manuela Dalibor, Bernhard Rumpe, Katrin Schilling, Andreas Wortmann</i>	

PARAMETRIC COMPENSATION SCHEME FOR INCREASING THE GEOMETRICAL ACCURACY OF LATTICE STRUCTURES IN MEDICAL IMPLANTS PRODUCED BY POWDER BED FUSION.....	839
<i>Max Horn, Lukas Koch, Mario Schafnitzel, Matthias Schmitt, Gunther Reinhart</i>	
A FRAMEWORK FOR SELECTING DATA ACQUISITION TECHNOLOGY IN SUPPORT OF RAILWAY INFRASTRUCTURE PREDICTIVE MAINTENANCE.....	845
<i>Johannes W. Van Schalkwyk, Johannes L. Jooste, Dominik Lucke</i>	
TRANSFORMATION OF INTERNATIONAL MANUFACTURING NETWORKS: CHANGES IN CONFIGURATION, UNDERLYING CAUSES AND POTENTIAL PATTERNS	851
<i>Simon Dreher, Christian Marchetti</i>	
SUSTAINABLE HUMAN-ROBOT CO-PRODUCTION FOR THE BICYCLE INDUSTRY	857
<i>Doris Aschenbrenner, Åsa Fasth Berglund, Matthijs Netten, Zoltan Rusak, Johan Stahre</i>	
THE DIGITAL TWIN IN ORDER PROCESSING.....	863
<i>Sarah Bernadette Wagner, Michael Milde, Gunther Reinhart</i>	
DATA-BASED QUALITY ANALYSIS IN MACHINING PRODUCTION: INFLUENCE OF DATA PRE-PROCESSING ON THE RESULTS OF MACHINE LEARNING MODELS	869
<i>Amina Ziegenbein, Joachim Metternich</i>	
FINITE ELEMENT MODELLING OF TEMPERATURE IN CYLINDRICAL GRINDING FOR FUTURE INTEGRATION IN A DIGITAL TWIN.....	875
<i>Arttu Heininen, Romaric Prod'Hon, Hossein Mokhtarian, Eric Coatanéa, Kari Koskinen</i>	
SEPARATING ENTANGLED WORKPIECES IN RANDOM BIN PICKING USING DEEP REINFORCEMENT LEARNING	881
<i>Marius Moosmann, Marco Kulig, Felix Spenrath, Manuel Mönnig, Marco F. Huber</i>	
TOWARDS DIGITALIZATION IN PRODUCTION IN SMES – A QUALITATIVE STUDY OF CHALLENGES, COMPETENCIES AND REQUIREMENTS FOR TRAININGS.....	887
<i>Maria Hulla, Patrick Herstätter, Matthias Wolf, Christian Ramsauer</i>	
POTENTIAL OF THE RECYCLING OF GRINDING SLUDGE BY VARIOUS POWDER METALLURGICAL PROCESSES	893
<i>Sebastian Jäger, Sebastian Weber, Arne Röttger</i>	
DATA-DRIVEN ANALYSIS OF PRODUCT PROPERTY PROPAGATION TO SUPPORT PROCESS-INTEGRATED QUALITY MANAGEMENT IN MANUFACTURING SYSTEMS.....	900
<i>Marc-André Filz, Sebastian Gellrich, Felix Lang, Jakob Zietsch, Christoph Herrmann</i>	
A MACHINE LEARNING-BASED IMAGE PROCESSING APPROACH FOR ROBOTIC ASSEMBLY SYSTEM.....	906
<i>Xi Vincent Wang, Jaume Soriano Pinter, Zhihao Liu, Lihui Wang</i>	
DEEP TRANSFER LEARNING FOR IMPROVED PRODUCT QUALITY PREDICTION: A CASE STUDY OF ALUMINUM GRAVITY DIE CASTING	912
<i>Sebastian Gellrich, Marc-André Filz, Anna-Sophia Wilde, Thomas Beganovic, Christoph Herrmann</i>	
A SYNTHESIS-BASED TOOL PATH PLANNING APPROACH FOR MACHINING OPERATIONS	918
<i>Tristan Schäfer, Jim A. Bergmann, Rafael Garcia Carballo, Jakob Rehof, Petra Wiederkehr</i>	

IDENTIFYING HUMAN INTENTION DURING ASSEMBLY OPERATIONS USING WEARABLE MOTION CAPTURING SYSTEMS INCLUDING EYE FOCUS	924
<i>Martin Manns, Tadele Belay Tuli, Florian Schreiber</i>	
PATH PLANNING FOR SIMULATING HUMAN MOTIONS IN MANUAL ASSEMBLY OPERATIONS	930
<i>Tadele Belay Tuli, Martin Manns, Christian Zöllner, Daniel Klein</i>	
HEAT TREATMENT EFFECT ON 17-4PH STAINLESS STEEL MANUFACTURED BY ATOMIC DIFFUSION ADDITIVE MANUFACTURING (ADAM).....	935
<i>M. A. Bouaziz, J. Marae Djouda, M. Chemkhi, M. Rambaudon, F. Hild</i>	
A MULTI-CRITERIA METHOD TO DESIGN THE COLLABORATION BETWEEN HUMANS AND ROBOTS.....	939
<i>Alessandra Papetti, Marianna Ciccarelli, Cecilia Scoccia, Michele Germani</i>	
TOWARDS ASSET ADMINISTRATION SHELL-BASED RESOURCE VIRTUALIZATION IN 5G ARCHITECTURE-ENABLED CYBER-PHYSICAL PRODUCTION SYSTEMS.....	945
<i>Daniel Stock, Matthias Schneider, Thomas Bauernhansl</i>	
INNOVATIVE RELATIONS WITHIN THE SOFTWARE APPLICATION FOR INDUSTRY 4.0.....	951
<i>Peter Pavol Monka, Katarina Monkova</i>	
EFFECTS OF MECHANICAL POST-TREATMENTS ON ADDITIVE MANUFACTURED 17-4PH STAINLESS STEEL PRODUCED BY BOUND POWDER EXTRUSION.....	957
<i>M. Chemkhi, J. Marae Djouda, M. A. Bouaziz, J. Kauffmann, D. Retraint</i>	
FABOS: TOWARDS AN OPEN, DISTRIBUTED, REAL-TIME-CAPABLE, AND SECURE OPERATING SYSTEM FOR PRODUCTION	962
<i>Martin Lukas, Daniel Stock, Akos Csiszar</i>	
MEASURING PHYSICAL AND MENTAL STRAIN DURING MANUAL ASSEMBLY TASKS.....	968
<i>Barbara Tropschuh, Sina Niehues, Gunther Reinhart</i>	
KNOWLEDGE DISCOVERY IN HETEROGENEOUS AND UNSTRUCTURED DATA OF INDUSTRY 4.0 SYSTEMS: CHALLENGES AND APPROACHES	975
<i>Simon Kamm, Nasser Jazdi, Michael Weyrich</i>	
ASSEMBLY SPECIFIC VIEWPOINT GENERATION AS PART OF A SIMULATION BASED SENSOR PLANNING PIPELINE.....	981
<i>Johann Gierecker, Thorsten Schüppstuhl</i>	
POTENTIALS OF TRACEABILITY SYSTEMS - A CROSS-INDUSTRY PERSPECTIVE.....	987
<i>Patrizia Gartner, Martin Benfer, Andreas Kuhnle, Gisela Lanza</i>	
CONFIGURATION OF MANUFACTURING NETWORKS BY A MULTI-OBJECTIVE PERSPECTIVE ENABLED BY SIMULATION AND MACHINE LEARNING.....	993
<i>Elias Auberger, Hugo Karre, Matthias Wolf, Heimo Preising, Christian Ramsauer</i>	
CONCEPT FOR INTERACTION OF HARDWARE SIMULATION AND EMBEDDED SOFTWARE IN A DIGITAL TWIN BASED TEST ENVIRONMENT	999
<i>Vladimir Kutscher, Thiago Weber Martins, Johannes Olbort, Reiner Anderl</i>	
COORDINATIVE SCHEDULING OF THE MOBILE ROBOTS AND MACHINES BASED ON HYBRID GA IN FLEXIBLE MANUFACTURING SYSTEMS	1005
<i>Sheng Qu, Yaoguang Hu, Weibo Ren, Xiaonan Yang</i>	

MARKING OF ELECTRODE SHEETS IN THE PRODUCTION OF LITHIUM-ION CELLS AS AN ENABLER FOR TRACKING AND TRACING	1011
<i>Alessandro Sommer, Matthias Leeb, Sajedah Haghi, Florian J. Günter, Gunther Reinhart</i>	
BOTTLENECK REDUCTION STRATEGIES FOR ENERGY EFFICIENCY IN THE BATTERY MANUFACTURING	1017
<i>Gabriela Ventura Silva, Matthias Thomitzek, Tim Abraham, Christoph Herrmann</i>	
ARTIFICIAL WEAR FOR THE ASSESSMENT OF MONITORING PERFORMANCE	1023
<i>Berend Denkena, Benjamin Bergmann, Tobias H. Stiehl</i>	
OBJECT DETECTION IN FACTORY BASED ON DEEP LEARNING APPROACH	1029
<i>Li Yi, Carina Siedler, Yann Kinkel, Moritz Glatt, Jan C. Aurich</i>	
CONTINUING ENGINEERING EDUCATION (CEE) IN CHANGEABLE AND RECONFIGURABLE MANUFACTURING USING PROBLEM-BASED LEARNING (PBL).....	1035
<i>Ann-Louise Andersen, Carin Rösiö</i>	
RETHINKING VALUE – A MEANS TO END THE WHISPERING GAME.....	1041
<i>Eivind Reke, Daryl Powell</i>	
A VISUALIZATION FRAMEWORK FOR PRODUCT MANUFACTURING DATA	1046
<i>Liu Xuemei, Yang Xiaolang</i>	
INTRODUCING INLINE PROCESS AND PRODUCT ANALYSIS FOR THE LEAN CELL FINALIZATION IN LITHIUM-ION BATTERY PRODUCTION	1052
<i>Sandro Stock, Amedeo Ceruti, Florian J. Günter, Gunther Reinhart</i>	
MODEL-BASED IDENTIFICATION OF PRODUCTION TOLERANCES IN BATTERY PRODUCTION	1059
<i>Matthias Thomitzek, Oke Schmidt, Tim Abraham, Felipe Cerdas, Christoph Herrmann</i>	
A DATA-DRIVEN DIGITAL TWIN OF CNC MACHINING PROCESSES FOR PREDICTING SURFACE ROUGHNESS	1065
<i>V. S. Vishnu, Kiran George Varghese, B. Gurumoorthy</i>	
STUDY ON CONFLICT-FREE AGVS PATH PLANNING STRATEGY FOR WORKSHOP MATERIAL DISTRIBUTION SYSTEMS.....	1071
<i>Xu Liyun, Wang Ning, Ling Xufeng</i>	
DELIVERY OPERATION TIME OPTIMIZATION OF MULTI-CRANE SCHEDULING IN STEEL PLATE YARD	1077
<i>Ma Shumei, Tao Ran, Xu Liyun, Yang Liansheng</i>	
TASK SCHEDULING FOR TIER-TO-TIER FOUR-WAY SHUTTLE WAREHOUSING SYSTEM	1083
<i>Xu Liyun, Liu Cong, Zhan Xiangnan, Ling Xufeng</i>	
TOWARDS THE RESILIENT OPERATOR 5.0: THE FUTURE OF WORK IN SMART RESILIENT MANUFACTURING SYSTEMS	1089
<i>David Romero, Johan Stahre</i>	
ENERGY FLEXIBILITY IN PRODUCTION PLANNING	1095
<i>Eduardo Colangelo, Silke Hartleif, Sebastian Hefner, Alexander Sauer</i>	

SYSTEMATIC PLANNING OF QUALITY INSPECTION STRATEGIES IN MANUFACTURING SYSTEMS	1101
<i>Marc-André Filz, Jan Philipp Bosse, Christoph Herrmann</i>	
A COMPUTER VISION SYSTEM FOR SAW BLADE CONDITION MONITORING	1107
<i>Nicolas Jourdan, Tobias Biegel, Volker Knauth, Max Von Buelow, Joachim Metternich</i>	
IMAGE-BASED STATE TRACKING IN AUGMENTED REALITY SUPPORTED ASSEMBLY OPERATIONS	1113
<i>Vasilios Zogopoulos, Merwan Birem, Roeland De Geest, Robbert Hofman, Dorothy Gors</i>	
A COMPARISON OF AND CRITICAL REVIEW ON CYCLE TIME ESTIMATION METHODS FOR HUMAN-ROBOT WORK SYSTEMS	1119
<i>Titanilla Komenda, Mathias Brandstötter, Sebastian Schlund</i>	
A TOOL FOR THE COMPARISON OF CONCEPT DESIGNS OF RECONFIGURABLE MANUFACTURING SYSTEMS	1125
<i>Alessia Napoleone, Thomas Ditlev Brunoe, Ann-Louise Andersen, Kjeld Nielsen</i>	
METHOD FOR DATA-DRIVEN NC-CODE OPTIMIZATION BASED ON DEXEL MATERIAL REMOVAL SIMULATION AND TOOL HOLDER VIBRATION MEASUREMENTS	1131
<i>G. Mauthner, M. Ehrendorfer, T. Trautner, C. Ramsauer, F. Bleicher</i>	
FOOD 4.0: IMPLEMENTATION OF THE AUGMENTED REALITY SYSTEMS IN THE FOOD INDUSTRY	1137
<i>Sandeep Jagtap, Prateek Saxena, Konstantinos Salonitis</i>	
AN EFFICIENT COST ESTIMATION FRAMEWORK FOR AEROSPACE APPLICATIONS USING MATLAB/SIMULINK	1143
<i>Konstantinos Bacharoudis, Heather Wilson, Stephen Goodfellow-Jones, Atanas Popov, Svetan Ratchev</i>	
A METHODOLOGY FOR FLEXIBLE CONFIGURATION OF CHANGE MANAGEMENT PROCESSES	1149
<i>Sajede Haghi, Fabian Sippl, Lukas Zink, Gunther Reinhart</i>	
A CONCEPTUAL FRAMEWORK TOWARDS DATA-DRIVEN MODELS IN ELECTRODE PRODUCTION OF LITHIUM-ION BATTERY CELLS.....	1155
<i>Sajede Haghi, Hans-Christoph Töpfer, Florian J. Günter, Gunther Reinhart</i>	
MACHINE LEARNING USE CASE IN MANUFACTURING – AN EVALUATION OF THE MODEL’S RELIABILITY FROM AN IT SECURITY PERSPECTIVE.....	1161
<i>Beatriz Bretones Cassoli, Amina Ziegenbein, Joachim Metternich, Siniša Đukanovic, Martin Laabs</i>	
DESIGN AND DEVELOPMENT OF AUTOMATION EQUIPMENT BASED ON DIGITAL TWINS AND VIRTUAL COMMISSIONING.....	1167
<i>Jesper Puggaard De Oliveira Hansen, Elias Ribeiro Da Silva, Arne Bilberg, Carsten Bro</i>	
DEVELOPMENT OF HANDLING SYSTEM CONCEPTS FOR ADDITIVE PROCESS CHAINS WITH LASER POWDER BED FUSION (L-PBF)	1173
<i>Rainer Horstkotte, Florian Heinrich, Marcel Prümmer, Kristian Arntz, Thomas Bergs</i>	
TOWARDS IDENTIFYING DATA ANALYTICS USE CASES IN PRODUCT PLANNING.....	1179
<i>Maurice Meyer, Melina Panzner, Christian Koldewey, Roman Dumitrescu</i>	

A MATURITY MODEL TO ASSESS DIGITAL EMPLOYEE COMPETENCIES IN INDUSTRIAL ENTERPRISES	1185
<i>Markus Steinlechner, Andreas Schumacher, Benedikt Fuchs, Luisa Reichsthaler, Sebastian Schlund</i>	
RISK MANAGEMENT IN FACTORY PLANNING – A LITERATURE REVIEW	1191
<i>Peter Burggräf, Tobias Adlon, Steffen Schupp, Jan Salzwedel</i>	
AUTOMATED 2D LAYOUT DESIGN OF ASSEMBLY LINE WORKSTATIONS THROUGH PHYSICAL PRINCIPLES	1197
<i>Carsten Seeber, Marcel Albus, Manuel Fechter, Alexander Neb, Satoshi I. Yoshida</i>	
AN IMPROVED PIGEON-INSPIRED OPTIMIZATION ALGORITHM FOR SOLVING DYNAMIC FACILITY LAYOUT PROBLEM WITH UNCERTAIN DEMAND	1203
<i>Xu Zhun, Xu Liyun, Ling Xufeng</i>	
THE ACCEPTANCE OF AUGMENTED REALITY AS A DETERMINING FACTOR IN INTRALOGISTICS PLANNING	1209
<i>Anke Rohacz, Steffen Strassburger</i>	
ONTOLOGY-BASED TRACEABILITY SYSTEM FOR INTEROPERABLE DATA ACQUISITION IN BATTERY CELL MANUFACTURING	1215
<i>Jacob Wessel, Artem Turetskyy, Olaf Wojahn, Tim Abraham, Christoph Herrmann</i>	
DEEP REINFORCEMENT LEARNING AS AN OPTIMIZATION METHOD FOR THE CONFIGURATION OF ADAPTABLE, CELL-ORIENTED ASSEMBLY SYSTEMS	1221
<i>Christoph Halbwidl, Thomas Sobottka, Alexander Gaal, Wilfried Sihn</i>	
DIGITAL TWIN: FINDING COMMON GROUND – A META-REVIEW	1227
<i>Kim Jessica Kuehner, Richard Scheer, Steffen Strassburger</i>	
A METHODOLOGICAL APPROACH FOR MONITORING ASSEMBLY PROCESSES	1233
<i>Mathias Nausch, Philipp Hold, Wilfried Sihn</i>	
AN APPROACH FOR KNOWLEDGE-DRIVEN, FLEXIBLE PROCESS GENERATION	1239
<i>Christian Fimmers, Simon Storms, Werner Herfs, Christian Brecher</i>	
DETERMINE SIMILARITY OF ASSEMBLY OPERATIONS USING SEMANTIC TECHNOLOGY	1245
<i>Iris Gräßler, Daniel Roesmann, Dominik Wiechel, Daniel Preuß, Jens Pottebaum</i>	
TOWARDS PREDICTIVE QUALITY IN PRODUCTION BY APPLYING A FLEXIBLE PROCESS-INDEPENDENT META-MODEL	1251
<i>Junjie Liang, Lukas Pelzer, Kai Müller, Simon Cramer, Robert H. Schmitt</i>	
SYNTHETIC TRAINING DATA GENERATION FOR VISUAL OBJECT IDENTIFICATION ON LOAD CARRIERS	1257
<i>Daniel Schoepflin, Dirk Holst, Martin Gomse, Thorsten Schüppstuhl</i>	
A TECHNOLOGICAL AND ECONOMIC POTENTIAL ANALYSIS OF MEASUREMENT SYSTEMS IN GEOMETRICAL QUALITY ASSURANCE	1263
<i>Philipp Bauer, Laurin Gottschall, Alejandro Magaña Flores, Andreas Hofer, Gunther Reinhart</i>	
A FRAMEWORK FOR DIGITAL TWINS FOR PRODUCTION NETWORK MANAGEMENT	1269
<i>Martin Benfer, Sina Peukert, Gisela Lanza</i>	

MODULAR DESIGN METHOD FOR RECONFIGURABLE MANUFACTURING SYSTEMS	1275
<i>Thomas Ditlev Brunoe, Daniel Gh Soerensen, Kjeld Nielsen</i>	
TOWARDS A CAD-BASED AUTOMATED ROBOT OFFLINE-PROGRAMMING APPROACH FOR DISASSEMBLY	1280
<i>Joshua Beck, Alexander Neb, Katharina Barbu</i>	
IMPACT OF MANUFACTURING-AS-A-SERVICE: BUSINESS MODEL ADAPTION FOR ENTERPRISES	1286
<i>Serdar Bulut, Martin Wende, Christoph Wagner, Reiner Anderl</i>	
CONCEPT AND ARCHITECTURE FOR INFORMATION EXCHANGE BETWEEN DIGITAL TWINS OF THE PRODUCT (CPS) AND THE PRODUCTION SYSTEM (CPPS).....	1292
<i>Anna Vogt, Ralph Klaus Müller, Thomas Kampa, Rainer Stark, Daniel Großmann</i>	
DEALING WITH HIGH DIMENSIONAL SEQUENCE DATA IN MANUFACTURING.....	1298
<i>Uzma Iffat, Eric Roseren, Mohamed Laib</i>	
SUPERVISED AND UNSUPERVISED LEARNING IN VISION-GUIDED ROBOTIC BIN PICKING APPLICATIONS FOR MIXED-MODEL ASSEMBLY	1304
<i>Patrik Fager, Robin Hanson, Åsa Fasth-Berglund, Sven Ekered</i>	
TOWARDS A ROBUST DIGITAL PRODUCTION AND LOGISTICS NETWORK BY IMPLEMENTING FLEXIBILITY MEASURES	1310
<i>Alexandra Birkmaier, Bernhard Oberegger, Andreas Felsberger, Gerald Reiner, Wilfried Sihl</i>	

PART 3

AI-BASED TOPOLOGY OPTIMIZATION OF FREEHAND SKETCHES	1316
<i>Enno Garrelts, Marco Huber, Daniel Roth, Hansgeorg Binz</i>	
ONTOLOGY-BASED PROCESS REENGINEERING TO SUPPORT DIGITALIZATION OF MRO OPERATIONS: APPLICATION TO AN AVIATION INDUSTRY CASE	1322
<i>Clemens Gróf, Alexander Kamtsiuris</i>	
INFLUENCE OF HEAT TREATMENT ON THE RESIDUAL STRESS-RELATED MACHINING DISTORTION OF TI-6AL-4V ALLOY MONOLITHIC PARTS	1328
<i>M. Landwehr, F. Oehler, H. Behnken, H. Holling, T. Bergs</i>	
AN APPROACH TO DATA STRUCTURING AND PREDICTIVE ANALYSIS IN DISCRETE MANUFACTURING.....	1334
<i>Christian Dalheim Øien, Sebastian Dransfeld</i>	
MODELLING PROTOCOL GATEWAYS FOR CYBER-PHYSICAL SYSTEMS USING ARCHITECTURE ANALYSIS & DESIGN LANGUAGE	1339
<i>Patrick Denzler, Daniel Scheuchenstuhl, Daniel Ramsauer, Wolfgang Kastner</i>	
STRUCTURAL OPTIMIZATION OF ADDITIVELY MANUFACTURED POLYMER TOOLS FOR FLEXIBLE SHEET METAL FORMING.....	1345
<i>Michael Geueke, Peter Frohn-Sörensen, Jonas Reuter, Nithin Padavu, Bernd Engel</i>	
DIGITALLY ENHANCED QUALITY MANAGEMENT FOR ZERO DEFECT MANUFACTURING.....	1351
<i>Daryl Powell, Ragnhild Eleftheriadis, Odd Myklebust</i>	

QUICK-SCAN – TOWARDS A STRATEGY FOR RESPONSIVE AND RESILIENT VALUE CHAINS	1355
<i>Daryl Powell, Eirin Lodgaard, Maria Flavia Mogos</i>	
AN ASSESSMENT TOOL FOR DIGITAL ENHANCEMENT OF OPERATORS ON THE PRODUCTION SHOP FLOOR	1361
<i>Marta Pinzone, Federica Acerbi, Emrah Arica, Manuel Oliveira, Marco Taisch</i>	
A DYNAMIC JOB ROTATION SCHEDULING CONCEPTUAL FRAMEWORK BY A HUMAN REPRESENTING DIGITAL TWIN	1367
<i>Venkata Krishna Rao Pabolu, Divya Shrivastava</i>	
DEVELOPMENT OF A METHOD FOR APPLYING FREE KINEMATICS FOR GEAR PROFILE GRINDING	1373
<i>Christopher Janßen, Jens Brimmers, Thomas Bergs</i>	
APPLICATION OF CONFIGURATION PRINCIPLE ON KNOWLEDGE-BASED ENGINEERING FOR MANUFACTURING SYSTEM DESIGN	1378
<i>Chen Zheng, Yushu An, Zhanxi Wang, Xiansheng Qin, Fei Yu</i>	
INSIGHTS FROM A DIGITAL LEAN STARTUP: CO-CREATING DIGITAL TOOLS FOR COGNITIVE AUGMENTATION OF THE WORKER	1384
<i>Daryl Powell, Manuel Oliveira</i>	
CONDITION MONITORING OF CRITICAL INDUSTRIAL ASSETS USING HIGH PERFORMING LOW-COST MEMS ACCELEROMETERS	1389
<i>Agusmian Partogi Ompusunggu, Kerem Eryilmaz, Karel Janssen</i>	
PRELIMINARY DESIGN OF ASSEMBLY SYSTEM AND OPERATIONS FOR LARGE MECHANICAL PRODUCTS USING A GAME ENGINE	1395
<i>George Vasilopoulos, George-Christopher Vosniakos</i>	
APPROACH FOR EFFICIENT ACQUISITION OF ENERGY DATA AND IDENTIFICATION OF ENERGY-RELATED PROCESS PARAMETERS IN LITHIUM-ION BATTERY CELL PRODUCTION	1401
<i>Maria Maier, Susanne Vernim, Gunther Reinhart</i>	
GENETIC ALGORITHM FOR THE OPTIMIZATION OF VISION ACQUISITION FOR ON-THE-FLY POSITION MEASUREMENT OF INDIVIDUAL LAYERS IN FUEL CELL STACK ASSEMBLY	1407
<i>Jens Schäfer, Simeon Allmendinger, Janna Hofmann, Jürgen Fleischer</i>	
STUDY OF THE INFLUENCE OF THE HARDENING RULE ON A MULTI-STEP GLOBAL MANUFACTURING PROCESS MODELING	1412
<i>Diego Britez, Sana Werda, Raynald Laheurte, Philippe Darnis, Olivier Cahuc</i>	
ADDITIVELY MANUFACTURED, PARTICLE-FILLED DAMPING STRUCTURES WITH MAGNETORHEOLOGICAL FLUIDS	1418
<i>Kim Torben Werkle, Christian Menze, Thomas Stehle, Hans-Christian Möhring</i>	
A LIFE CYCLE COST ANALYSIS METHOD ACCELERATING IOT IMPLEMENTATION IN SMES	1424
<i>Yuya Mitake, Yusuke Tsutsui, Salman Alfarihi, Mar'Atus Sholihah, Yoshiki Shimomura</i>	
HOLISTIC CONCEPT TOWARDS A REFERENCE ARCHITECTURE MODEL FOR PREDICTIVE MAINTENANCE	1430
<i>Eckart Uhlmann, Julian Polte, Nikolaos-Stefanos Koutrakis</i>	

AUTOMATED POROSITY ASSESSMENT OF PARTS PRODUCED BY LASER POWDER BED FUSION USING CONVOLUTIONAL NEURAL NETWORKS	1434
<i>Jan Klein, Martin Jaretzki, Michael Schwarzenberger, Steffen Ihlenfeldt, Welf-Guntram Drossel</i>	
AUTOMATIC BUILDING OF A REPOSITORY FOR COMPONENT-BASED SYNTHESIS OF WAREHOUSE SIMULATION MODELS	1440
<i>Fadil Kallat, Jakob Pfrommer, Jan Bessai, Jakob Rehof, Anne Meyer</i>	
TRANSPARENT AND INTERPRETABLE FAILURE PREDICTION OF SENSOR TIME SERIES DATA WITH CONVOLUTIONAL NEURAL NETWORKS	1446
<i>Richard Meyes, Nils Hütten, Tobias Meisen</i>	
THE ROLE OF AUTOMATION IN COMPLEXITIES OF HIGH-MIX IN LOW-VOLUME PRODUCTION – A LITERATURE REVIEW.....	1452
<i>Kerstin Johansen, Sagar Rao, Milad Ashourpour</i>	
ASSESSMENT OF RECONFIGURABILITY LEVEL WITHIN EXISTING MANUFACTURING SYSTEMS	1458
<i>Simon Boldt, Carin Rösio, Adam Bergström, Luisa Jödicke</i>	
DYNAMIC PROPERTIES OF AN AIR BEARING DRIVE SYSTEM FOR MANUFACTURING OF TWIST-FREE SURFACES BY START-STOP TURNING.....	1464
<i>František Žurek, Thomas Junge, Andreas Nestler, Stephan Schaller, Andreas Schubert</i>	
MACHINE LEARNING OF PARAMETERS FOR STRUCTURAL PET FOAM MILLING.....	1470
<i>Moritz Haas, Juergen Lenz, Dieter Joenssen, Wolfgang Rimkus, Dominic Lutz</i>	
IDENTIFICATION OF WORKPLACE-RELATED TURNOVER PREDICTORS IN PRODUCTION	1476
<i>Svenja Korder, Moritz Krauel, Susanne Vernim, Gunther Reinhart</i>	
EVOLUTIONARY OPTIMIZATION OF DEEP-DRAWING PROCESSES ON SERVO SCREW PRESSES WITH FREELY PROGRAMMABLE FORCE AND MOTION FUNCTIONS	1482
<i>Sebastian Kriechenbauer, Peter Müller, Reinhard Mauermann, Welf-Guntram Drossel</i>	
SMART MANUFACTURING IN THE WOODEN SINGLE-FAMILY HOUSE INDUSTRY – STATUS OF INDUSTRY 4.0.....	1488
<i>Alexander Vestin, Kristina Säfsten</i>	
PREDICTION ASSESSMENT METHODOLOGY FOR MAINTENANCE APPLICATIONS IN MANUFACTURING	1494
<i>P. Aivaliotis, Z. Arkouli, D. Kaliakatsos-Georgopoulos, S. Makris</i>	
A DESIGN OF HUMAN AND OVERHEAD ROBOT INTERACTION (HORI) FRAMEWORK FOR COOPERATIVE ROBOTIC APPLICATIONS IN COPPER INDUSTRY.....	1500
<i>P. Aivaliotis, D. Kaliakatsos-Georgopoulos, A. Papavasileiou, S. Makris</i>	
A FRACTAL CONTROL SYSTEM ARCHITECTURE FOR NEXT GENERATION FACTORIES	1506
<i>Maximilian Raphael Visotschnig, Jürgen Henke, Dominik Lucke</i>	
VISUALIZATION OF SPATIALLY RESOLVED ENERGY IN WIRE ELECTRICAL DISCHARGE MACHINING	1512
<i>Ugur Küpper, Tim Herrig, Thomas Bergs</i>	

PDCA INTEGRATED SIMULATIONS ENABLE EFFECTIVE DEPLOYMENT OF COLLABORATIVE ROBOTS: CASE OF A MANUFACTURING SME.....	1518
<i>Mohsin Raza, Ali Ahmad Malik, Arne Bilberg</i>	
SIMULTANEOUS PRODUCTION AND AGV SCHEDULING USING MULTI-AGENT DEEP REINFORCEMENT LEARNING	1523
<i>Jens Popper, Vassilios Yfantis, Martin Ruskowski</i>	
AIMING FOR INDUSTRY 4.0 MATURITY? THE RISK OF HIGHER DIGITALIZATION LEVELS IN BUYER-SUPPLIER RELATIONSHIPS	1529
<i>Markus Burger, Melanie Kessler, Julia Arlinghaus</i>	
VISION-BASED ASSOCIATIVE ROBOTIC RECOGNITION OF WORKING STATUS IN AUTONOMOUS MANUFACTURING ENVIRONMENT.....	1535
<i>Feiyu Jia, Yongsheng Ma, Rafiq Ahmad</i>	
HYBRID APPROACH FOR ONSITE MONITORING AND ANOMALY DETECTION OF CUTTING TOOL LIFE	1541
<i>Zhenzhi Ying, Liming Shu, Toru Kizaki, Masatoshi Iwama, Naohiko Sugita</i>	
SCALABLE ANOMALY DETECTION IN MANUFACTURING SYSTEMS USING AN INTERPRETABLE DEEP LEARNING APPROACH.....	1547
<i>Thomas Schlegl, Stefan Schlegl, Nikolai West, Jochen Deuse</i>	
A MULTI-LEVEL MODEL FOR REALIZING DATA-DRIVEN MAINTENANCE IN MANUFACTURING ENTERPRISES: USE CASE OF JEWELRY PRODUCTION.....	1553
<i>Klaudia Kovacs, Clemens Heistracher, Jakob Giner, Wilfried Sihn, Jürgen Schneeweiss</i>	
PHYSICS-INFORMED NEURAL NETWORKS (PINNS) FOR IMPROVING A THERMAL MODEL IN STEREOLITHOGRAPHY APPLICATIONS	1559
<i>Georges Tod, Agusman Partogi Ompusunggu, Gunther Struyf, Goele Pipeleers, Erik Hostens</i>	
A FRAMEWORK FOR ADVANCED VISUALIZATION OF PREDICTIVE ANALYTICS IN CYBER-PHYSICAL PRODUCTION SYSTEMS	1565
<i>Georgios Siaterlis, Marco Franke, Konstantin Klein, Karl A. Hribernik, Kosmas Alexopoulos</i>	
INTELLIGENT WASTE MANAGEMENT SYSTEM FOR METALWORK-COPPER INDUSTRY.....	1571
<i>P. Aivaliotis, I. Anagiannis, N. Nikolakis, K. Alexopoulos, S. Makris</i>	
ADAPTIVE SELF-LEARNING DISTRIBUTED AND CENTRALIZED CONTROL APPROACHES FOR SMART FACTORIES	1577
<i>Oliver Antons, Julia C. Arlinghaus</i>	
DATA DRIVEN AUTOMATIC PARAMETER INFERENCE FOR ROBOTIC ASSEMBLY PROGRAMS	1583
<i>Philipp Stephan, Jessica Fisch, Alperen Can, Oliver Heimann, Jörg Krüger</i>	
IDENTIFYING ENERGY FLEXIBLE MANUFACTURING LAYOUTS IN A LIGHT METAL FOUNDRY.....	1589
<i>Samleben Stefanie, Schleich Christoph, Schenk Michael</i>	
X-PHM: PROGNOSTICS AND HEALTH MANAGEMENT KNOWLEDGE-BASED FRAMEWORK FOR SME	1595
<i>Nabil Omri, Zeina Al Masry, Nicolas Mairot, Sylvian Giampiccolo, Nouredine Zerhouni</i>	

ON ASSESSING GRINDABILITY OF RECYCLED AND ORE-BASED CRANKSHAFT STEEL: AN APPROACH COMBINING DATA ANALYSIS WITH MATERIAL SCIENCE	1601
<i>Philipp Hoier, Peter Hammersberg, Uta Klement, Peter Krajnik</i>	
REAL-TIME COMBINATION OF MATERIAL FLOW SIMULATION, DIGITAL TWINS OF MANUFACTURING CELLS, AN AGV AND A MIXED-REALITY APPLICATION.....	1607
<i>Marcel Müller, Jonas Mielke, Yurii Pavlovskiy, Andreas Pape, Sebastian Häberer</i>	
DEVELOPMENT OF A SYSTEMATIC APPROACH TO IDENTIFY NON-VALUE-ADDING OPERATIONS IN THE LBM PROCESS CHAIN.....	1613
<i>Hajo Groneberg, Jan Koller, Alexander Mahr, Frank Döpfer</i>	
DECISION SUPPORT FOR FRUGAL PRODUCTS AND PRODUCTION SYSTEMS BASED ON PRODUCT-PROCESS-RESOURCE-SKILL & VARIABILITY MODELS	1619
<i>Yazgül Fidan, Arndt Lüder, Kristof Meixner, Laura Baumann, Julia C. Arlinghaus</i>	
A HYBRID TEACHING FACTORY MODEL FOR SUPPORTING THE EDUCATIONAL PROCESS IN COVID-19 ERA.....	1626
<i>Dimitris Mourtzis, Nikos Panopoulos, John Angelopoulos, Stelios Zygomalas, Panos Stavropoulos</i>	
COMPARATIVE ANALYSIS OF THE LIFE CYCLE ASSESSMENT FOR THE ASSEMBLY OPERATIONS OF RAILCAR COMPONENTS.....	1632
<i>Ilesanmi Daniyan, Khumbulani Mpofo, Boitumelo Ramatsetse, Rumbidzai Muvunzi</i>	
A COLLABORATIVE APPROACH ON ENERGY-BASED OFFERED SERVICES: ENERGY 4.0 ECOSYSTEMS	1638
<i>Dimitris Mourtzis, John Angelopoulos, Nikos Panopoulos</i>	
LIFE CYCLE OF A DIGITAL RESOURCE TWIN: META-MODELING AND APPLICATION EXAMPLE	1644
<i>Martin Sjarov, Tobias Lechler, Eva Russwurm, Jonathan Fuchs, Jörg Franke</i>	
A DECISION SUPPORT METHOD FOR KNOWLEDGE-BASED ADDITIVE MANUFACTURING PROCESS SELECTION	1650
<i>Harry Bikas, Nikolas Porevopoulos, Panagiotis Stavropoulos</i>	
QUALITY MONITORING OF MANUFACTURING PROCESSES BASED ON FULL DATA UTILIZATION.....	1656
<i>Panagiotis Stavropoulos, Alexios Papacharalampopoulos, Kyriakos Sabatakakis, Dimitris Mourtzis</i>	
MULTI-OBJECTIVE OPERATING POINT OPTIMIZATION OF MANUFACTURING SYSTEMS.....	1662
<i>Paul Molenda, Tom Drews, Oliver Oechsle</i>	
A METHODOLOGY FOR THE ASSESSMENT OF OPERATOR 4.0 SKILLS BASED ON SENTIMENT ANALYSIS AND AUGMENTED REALITY	1668
<i>Dimitris Mourtzis, John Angelopoulos, Vasilis Siatras, Nikos Panopoulos</i>	
DEVELOPMENT AND IMPLEMENTATION OF A DIGITAL MANUFACTURING DEMONSTRATOR FOR ENGINEERING EDUCATION	1674
<i>Shane Keaveney, Lydia Athanasopoulou, Vasilis Siatras, Panagiotis Stavropoulos, Denis P. Dowling</i>	

FLEXIBLE WORKFORCE ALLOCATION AS DRIVER OF ECONOMIC AND HUMAN-ORIENTED SHOP FLOOR ORGANIZATION.....	1680
<i>Sebastian Häberer, Julia Arlinghaus</i>	
A SMART IOT PLATFORM FOR ONCOLOGY PATIENT DIAGNOSIS BASED ON AI: TOWARDS THE HUMAN DIGITAL TWIN.....	1686
<i>Dimitris Mourtzis, John Angelopoulos, Nikos Panopoulos, Dimitrios Kardamakis</i>	
HYPERCONNECTED ARCHITECTURE FOR HIGH COGNITIVE PRODUCTION PLANTS.....	1692
<i>Francisco Javier Huertos, Manuel Masenlle, Beatriz Chicote, Mikel Ayuso</i>	
A METHOD TO SOLVE 2D FACILITY LAYOUT PROBLEM WITH EQUIPMENT INPUTS/OUTPUTS CONSTRAINTS USING META-HEURISTICS ALGORITHMS.....	1698
<i>Mariem Besbes, Marc Zolghadri, Roberta Costa Affonso</i>	
REALISTIC SIMULATION OF ROBOTIC GRASPING TASKS: REVIEW AND APPLICATION.....	1704
<i>Matthew Connolly, Aswin K Ramasubramanian, Matthew Kelly, Jack McEvoy, Nikolaos Papakostas</i>	
DISRUPTION ATTRIBUTES FOR LOW-VOLUME, COMPLEX PRODUCT ASSEMBLY	1710
<i>Stephan Breiter, Julia C. Arlinghaus</i>	
METHODOLOGY FOR ASSESSING, EVALUATING AND SELECTING AN INTEGRATION AND MIGRATION STRATEGY FOR INDUSTRY 4.0 IN SME.....	1716
<i>Oliver Oechsle, Tom Drews, Paul Molenda</i>	
DESIGN AND IMPLEMENTATION OF A DIGITAL TWIN PLATFORM FOR AM PROCESSES.....	1722
<i>Panagiotis Stavropoulos, Alexios Papacharalampoulous, Konstantinos Tzimanis</i>	
IMPACT OF ARTIFICIAL INTELLIGENCE ON ENGINEERING: PAST, PRESENT AND FUTURE	1728
<i>Robert W. Blake, Robins Mathew, Abraham George, Nikolaos Papakostas</i>	
PROPOSITIONS ON THE BENEFITS OF THE ORGANIZATIONAL EDUCATION PERSPECTIVE TOWARDS REALIZING INDUSTRY 4.0-PROMISES	1734
<i>Alinde Keller, Susanne M. Weber, Julia C. Arlinghaus</i>	
TOWARDS SMART MANUFACTURING LOGISTICS: A CASE STUDY OF POTENTIALS OF SMART LABEL DATA IN ELECTRONICS MANUFACTURING	1741
<i>Daniel Mueller, Florian Vogelsang</i>	
HIGH STRENGTH ALUMINIUM ALLOYS IN LASER-BASED POWDER BED FUSION – A REVIEW	1747
<i>Julie Langedahl Leirmo</i>	
A 3D DEEP LEARNING MODEL FOR RAPID PREDICTION OF STRUCTURAL DYNAMICS OF WORKPIECES DURING MACHINING.....	1753
<i>Ali Maghami, Meshkat Salehi, Matt Khoshdarregi</i>	
QUALITY CONTROL OF WHITE GOODS PARTS USING ROBOTIC TECHNOLOGIES.....	1759
<i>Panagiotis Karagiannis, Vangelis Xanthakis, George Apostolopoulos, George Michalos, Sotiris Makris</i>	

DEEP LEARNING-BASED OPTICAL INSPECTION OF RIGID AND DEFORMABLE LINEAR OBJECTS IN WIRING HARNESSSES	1765
<i>Huong Giang Nguyen, Jörg Franke</i>	
DESIGN AND IMPLEMENTATION OF A HOLISTIC FRAMEWORK FOR DATA INTEGRATION IN INDUSTRIAL MACHINE AND SENSOR NETWORKS.....	1771
<i>Jonas Hillenbrand, Philipp Gönnheimer, Eduard Gerlitz, Jürgen Fleischer</i>	
DESIGN AND CONFIGURATION OF DIGITAL ASSISTANCE SYSTEMS IN MANUAL ASSEMBLY OF VARIANT-RICH PRODUCTS BASED ON CUSTOMER JOURNEY MAPPING	1777
<i>Bastian Pokorni, Carmen Constantinescu</i>	
AFFECTIVE PRODUCTION SYSTEMS: FOUNDATIONS, REFERENCE MODEL AND ROADMAP FOR IMPLEMENTATION AND VALIDATION	1783
<i>Carmen Constantinescu, Bastian Pokorni, Johannes Wimmer</i>	
A GENERIC HYBRID HUMAN/EXOSKELETON DIGITAL MODEL TOWARDS DIGITAL TRANSFORMATION OF EXOSKELETONS-INTEGRATED WORKPLACES	1787
<i>Claudiu-Alin Rusu, Carmen Constantinescu, Sergiu-Cosmin Marinescu</i>	
CONCEPT AND METHODOLOGY FOR AUTOMATED DATA PREPROCESSING OF OBJECT RECOGNITION ALGORITHM TRAINING	1791
<i>Stefan Giosan, Raul Matei, Vlad-Calin Albota, Carmen Constantinescu</i>	
TRANSFER LEARNING-ENABLED ACTION RECOGNITION FOR HUMAN-ROBOT COLLABORATIVE ASSEMBLY	1795
<i>Shufei Li, Junming Fan, Pai Zheng, Lihui Wang</i>	
AUTOMATIC ASSEMBLY QUALITY INSPECTION BASED ON AN UNSUPERVISED POINT CLOUD DOMAIN ADAPTATION MODEL	1801
<i>Xiaomeng Zhu, Himaja Manamasa, Juan Luis Jiménez Sánchez, Atsuto Maki, Lars Hanson</i>	
A REINFORCEMENT LEARNING MODEL FOR MATERIAL HANDLING TASK ASSIGNMENT AND ROUTE PLANNING IN DYNAMIC PRODUCTION LOGISTICS ENVIRONMENT.....	1807
<i>Yongkuk Jeong, Tarun Kumar Agrawal, Erik Flores-García, Magnus Wiktorsson</i>	
IOT AND MACHINE LEARNING FOR IN-SITU PROCESS CONTROL USING LASER BASED ADDITIVE MANUFACTURING (LBAM) CASE STUDY.....	1813
<i>David Miller, Boyang Song, Michael Farnsworth, Divya Tiwari, Ashutosh Tiwari</i>	
A PRESCRIPTIVE MAINTENANCE SYSTEM FOR INTELLIGENT PRODUCTION PLANNING AND CONTROL IN A SMART CYBER-PHYSICAL PRODUCTION LINE	1819
<i>Antonio Padovano, Francesco Longo, Letizia Nicoletti, Lucia Gazzaneo, Simone Talarico</i>	
PART QUALITY PREDICTION IN MULTISTAGE MACHINING PROCESSES WITH FIXTURES BASED ON LOCATING SURFACES USING DUAL QUATERNIONS	1825
<i>Filmon Yacob, Daniel Semere</i>	
COMPLEXITY THEORY AND SELF-ORGANIZATION IN CYBER-PHYSICAL PRODUCTION SYSTEMS	1831
<i>Luis Alberto Estrada-Jimenez, Terrin Pulikottil, Ricardo Silva Peres, Sanaz Nikghadam-Hojjati, Jose Barata</i>	

OPTIMIZING RECONFIGURABLE MANUFACTURING SYSTEMS: A SIMULATION-BASED MULTI-OBJECTIVE OPTIMIZATION APPROACH	1837
<i>Carlos Alberto Barrera Diaz, Masood Fathi, Tehseen Aslam, Amos H. C. Ng</i>	
A MULTI-OBJECTIVE TOOL SELECTION METHOD USING FAHP AND COSINE SIMILARITY	1843
<i>Yuchen Long, Wu Zhao, Ling Chen</i>	
STUDY ON MACHINING PROCESS PERFORMANCE OF TURBINE BLADE BASED BY MQL	1849
<i>Ling Chen, Xin Guo, Zengfeng Duan, Xun Yang</i>	
COOPERATIVE CO-EVOLUTION AND DATA MINING FOR PLANNING DISASSEMBLY SEQUENCE AND ESTIMATING TIME.....	1855
<i>Yu-Yao Guo, Lei Wang, Ze-Lin Zhang, Xu-H Xia, Hui-Xian Zhu</i>	
HETEROGENEOUS REQUIREMENT GATHERING FOR GENERATIVE DESIGN OF ROBOTIC MANUFACTURING SYSTEMS.....	1861
<i>Chen Zheng, Yushu An, Zhanxi Wang, Xiansheng Qin, Yicha Zhang</i>	
DIGITAL MANUFACTURING AS A BASIS FOR THE DEVELOPMENT OF THE INDUSTRY 4.0 MODEL.....	1867
<i>Vojin Vukadinovic, Vidosav Majstorovic, Jovan Zivkovic, Slavenko Stojadinovic, Dragan Djurdjanovic</i>	
DISASSEMBLY INFORMATION INTEROPERABILITY FOR ELECTRIC VEHICLE BATTERY IN REMANUFACTURING BASED ON STEP STANDARDS.....	1873
<i>Jinhua Xiao, Weidong Li, Yaqiong Lv, Guangchao Du</i>	
DEEP FUSION FOR ENERGY CONSUMPTION PREDICTION IN ADDITIVE MANUFACTURING.....	1878
<i>Fu Hu, Jian Qin, Yixin Li, Ying Liu, Xianfang Sun</i>	
MULTI-SOURCED MODELLING FOR STRIP BREAKAGE USING KNOWLEDGE GRAPH EMBEDDINGS.....	1884
<i>Zheyuan Chen, Ying Liu, Agustin Valera-Medina, Fiona Robinson</i>	
PRODUCTION SPECIFIC LANGUAGE CHARACTERISTICS TO IMPROVE NLP APPLICATIONS ON THE SHOP FLOOR.....	1890
<i>Marvin Müller, Joachim Metternich</i>	
METHOD FOR THE GENERATION OF USE CASE RELATED VIEWS FOR DIGITAL TWINS	1896
<i>Stefan Kugler, Alexander Kern, Reiner Anderl</i>	
CONCEPTUAL USE CASES FOR INTEGRATING ARTIFICIAL INTELLIGENCE IN CYBER-PHYSICAL TWINS.....	1901
<i>Cordula Czwick, Reiner Anderl</i>	
SELF-TRAINED CAD ASSISTANCE FOR CONSTRAINING ASSEMBLIES BASED ON DECISION TREES AND SUPPORT VECTOR CLASSIFICATION	1907
<i>Thomas Dasbach, Robin Lohr, Florian Muth, Reiner Anderl</i>	
A SMART MANUFACTURING CELL WITH DISTRIBUTED INTELLIGENCE.....	1912
<i>Santhana Pandiyan Muniraj, Carter Apas-Cree, Jordan Roberts Radford, Jan Polzer, Xun Xu</i>	

COMPARISON BETWEEN DATA MATURITY AND MAINTENANCE STRATEGY: A CASE STUDY	1918
<i>Lucas Peter Høj Brasen, Oliver Fuglsan Groos, Torben Tambo</i>	
IMPROVED EMPIRICAL WAVELET DENOISING ALGORITHM WITH APPLICATION TO WHIRLING DETECTION IN DEEP HOLE DRILLING PROCESS	1924
<i>Yue Si, Xuyang Li, Lingfei Kong, Jianming Zhen, Yan Li</i>	
CUSTOMIZABLE OPERATION CENTER FOR SMART SECURITY MANAGEMENT	1930
<i>Christoph Engel, Steffen Mencke, Robert Heumüller, Ricardo Hormann, Frank Ortmeier</i>	
FACILITATING MODEL-BASED DESIGN OF CYBER-MANUFACTURING SYSTEMS	1936
<i>Hugo Daniel Macedo, Claudio Sassanelli, Peter Gorm Larsen, Sergio Terzi</i>	
SOLVING FACILITY LAYOUT PROBLEM WITH SAFETY CONSIDERATION OF RECONFIGURABLE MANUFACTURING AND ASSEMBLY SYSTEMS.....	1942
<i>Mariem Besbes, Yassine Idel Mahjoub, Therese Bonte, Thierry Berger, Marc Zolghadri</i>	
PREDICTIVE MAINTENANCE IN INDUSTRY 4.0: CURRENT THEMES	1948
<i>Ayman Sahl, Richard Evans, Arthi Manohar</i>	
WORKAROUNDS IN APPLICATION AND USE OF MANUFACTURING SOFTWARE AS ENABLERS TO ORGANIZATIONAL CHANGE	1954
<i>Catrine Eleonor Larsson, Bjørn Andersen, Kristian Martinsen</i>	
SMART MANUFACTURING AND TACTILE INTERNET POWERED BY 5G: INVESTIGATION OF CURRENT DEVELOPMENTS, CHALLENGES, AND FUTURE TRENDS	1960
<i>Dimitris Mourtzis</i>	

Author Index