

53rd CIRP Conference on Manufacturing Systems (CMS 2020)

Procedia CIRP Volume 93

Chicago, Illinois, USA
1 – 3 July 2020

Part 1 of 2

Editors:

**Robert X. Gao
Kornel Ehmann**

ISBN: 978-1-7138-1880-9

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. (2020)

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

PREFACE	1
<i>Robert X. Gao, Kornel Ehmann, Jian Cao</i>	
<u>ADDITIVE MANUFACTURING</u>	
TOWARDS THE INTEGRATION OF ADDITIVELY MANUFACTURED PHOTOPOLYMER DIES IN THE POLYMER PROFILE EXTRUSION PROCESS CHAIN	3
<i>A. Turazza, A. Davoudinejad, M. Calaon, D. B. Pedersen, G. Tosello</i>	
THERMAL STABILITY AND REACTIVITY OF TITANIUM HALIDE PRECURSORS FOR THE ATOMIC LAYER DEPOSITION OF TiO ₂ ON A Pt (111) SURFACE.....	9
<i>Lesego M Mohlala, Tien-Chien Jen, Peter Apata Olubambi</i>	
TOWARDS OPERATING CURVES OF ADDITIVE MANUFACTURING EQUIPMENT: PRODUCTION LOGISTICS AND ITS CONTRIBUTION TO INCREASED PRODUCTIVITY AND REDUCED THROUGHPUT TIME.....	14
<i>Tobias Stittgen, Johannes Henrich Schleifenbaum</i>	
SHEET METAL FORMING USING ADDITIVELY MANUFACTURED POLYMER TOOLS	20
<i>Günther Schuh, Georg Bergweiler, Philipp Bickendorf, Falko Fiedler, Can Colag</i>	
ON THE IMPLEMENTATION OF METAL ADDITIVE MANUFACTURING IN THE TOOLING PROCESS CHAIN FOR POLYMER PROFILE EXTRUSION	26
<i>M. Kain, M. Calaon, D. B. Pedersen, G. Tosello</i>	
AN INDUSTRY 4.0 FRAMEWORK FOR TOOLING PRODUCTION USING METAL ADDITIVE MANUFACTURING-BASED FIRST-TIME-RIGHT SMART MANUFACTURING SYSTEM	32
<i>Mandaná Moshiri, Amal Charles, Ahmed Elkaseer, Steffen Scholz, Guido Tosello</i>	
METHOD FOR GENERATING MANUFACTURABLE, TOPOLOGY-OPTIMIZED PARTS FOR LAMINATED LAYER MANUFACTURING	38
<i>Nico Helfesrieder, Armin Lechler, Alexander Verl</i>	
ESTIMATION OF RESIDUAL STRESS AND DEFORMATION IN SELECTIVE LASER MELTING OF Ti6Al4V ALLOY.....	44
<i>Hong Seok Park, Md Jonaet Ansari</i>	
MULTI-MATERIAL ADDITIVE MANUFACTURING – RECYCLING OF BINARY METAL POWDER MIXTURES BY SCREENING	50
<i>Max Horn, Lena Prestel, Matthias Schmitt, Maximilian Binder, Gunther Reinhart</i>	
AUTOMATED FEATURE EXTRACTION FOR HYBRID ADDITIVE-SUBTRACTIVE REMANUFACTURING	56
<i>Yufan Zheng, Rafiq Ahmad</i>	

TOPOLOGY OPTIMISATION AND METAL BASED ADDITIVE MANUFACTURING OF WELDING JIG ELEMENTS.....	62
<i>Günther Schuh, Georg Bergweiler, Kolja Lichtenthäler, Falko Fiedler, Sergio De La Puente Rebollo</i>	
ANISOTROPY OF ADDITIVELY MANUFACTURED 18NI-300 MARAGING STEEL: THREADS AND SURFACE CHARACTERISTICS	68
<i>Rizwan Ullah, Jan Sher Akmal, Sampsa Laakso, Esko Niemi</i>	
A STUDY ON IMPACT FACTORS OF THE ENERGY CONSUMPTION OF THE FUSED DEPOSITION MODELING PROCESS USING TWO-LEVEL FULL FACTORIAL EXPERIMENTS	79
<i>Li Yi, Tianwen Chen, Svenja Ehmsen, Christopher Gläßner, Jan C. Aurich</i>	
FEATURE-BASED PRINT METHOD FOR MULTI-AXIS MATERIAL EXTRUSION IN ADDITIVE MANUFACTURING	85
<i>Günther Schuh, Georg Bergweiler, Gerret Lukas, Steffen Hohenstein, Jan Schenk</i>	
TOWARDS TEMPERATURE CONTROL MEASURES FOR POLYMER ADDITIVE INJECTION MOLDS.....	90
<i>Günther Schuh, Georg Bergweiler, Gerret Lukas, Matthias Oly</i>	
ATTENTION MECHANISM-INCORPORATED DEEP LEARNING FOR AM PART QUALITY PREDICTION	96
<i>Jianjing Zhang, Peng Wang, Robert X. Gao</i>	
FEASIBILITY AND PROCESS CAPABILITY OF POLYMER ADDITIVE INJECTION MOLDS WITH SLIDE TECHNOLOGY	102
<i>Günther Schuh, Georg Bergweiler, Gerret Lukas, Josef A. Abrams</i>	
CLAMPING AND SUBSTRATE PLATE SYSTEM FOR CONTINUOUS ADDITIVE BUILD-UP AND POST-PROCESSING OF METAL PARTS.....	108
<i>Moritz Wollbrink, Semir Maslo, Daniel Zimmer, Karim Abbas, Thomas Bergs</i>	
CHALLENGES AND PROPOSED SOLUTIONS FOR ALUMINIUM IN LASER POWDER BED FUSION.....	114
<i>Julie Langedahl Leirimo, Ivanna Baturynska</i>	
NEAR-FIELD ELECTROSPINNING ON NONCONDUCTIVE SUBSTRATES USING AC FIELDS	120
<i>Nicolas Martinez-Prieto, Kornel Ehmann, Jian Cao</i>	
<u>BATTERY MANUFACTURING</u>	
INTEGRATION OF TRACEABILITY SYSTEMS IN BATTERY PRODUCTION	125
<i>Günther Riexinger, Joachim Peter Doppler, Christoph Haar, Michael Trierweiler, Thomas Bauernhansl</i>	
AUTOMATED ASSEMBLY OF LI-ION VEHICLE BATTERIES: A FEASIBILITY STUDY	131
<i>Ryan D'Souza, John Patsavellas, Konstantinos Salonitis</i>	
FLEXIBLE PRODUCTION CONCEPT OF A LOW-COST BATTERY PACK HOUSING FOR ELECTRIC VEHICLES.....	137
<i>Günther Schuh, Georg Bergweiler, Falko Fiedler, Marcel Koltermann</i>	

DESIGN AND EVALUATION OF A MATERIAL-ADAPTED HANDLING SYSTEM FOR ALL-SOLID-STATE LITHIUM-ION BATTERY PRODUCTION	143
<i>Arian Fröhlich, Dominik Gresens, Benjamin Vervoort, Klaus Dröder</i>	

MODELING OF THE CALENDERING PROCESS FOR LITHIUM-ION BATTERIES WITH DEM SIMULATION	149
<i>David Schreiner, André Klinger, Gunther Reinhart</i>	

BATTERY MANUFACTURING/SYS+

APPLICATION OF THIN LITHIUM FOIL FOR DIRECT CONTACT PRELITHIATION OF ANODES WITHIN LITHIUM-ION BATTERY PRODUCTION	156
<i>Benedikt Stumper, Andreas Mayr, Gunther Reinhart</i>	

TRACKING AND TRACING FOR DATA MINING APPLICATION IN THE LITHIUM-ION BATTERY PRODUCTION	162
<i>Jacob Wessel, Artem Turetsky, Olaf Wojahn, Christoph Herrmann, Sebastian Thiede</i>	

DATA-DRIVEN CYBER-PHYSICAL SYSTEM FOR QUALITY GATES IN LITHIUM-ION BATTERY CELL MANUFACTURING	168
<i>Artem Turetsky, Jacob Wessel, Christoph Herrmann, Sebastian Thiede</i>	

CYBERPHYSICAL SYSTEMS

OPERATING DIGITAL MANUFACTURING IN INDUSTRY 4.0: THE ROLE OF ADVANCED MANUFACTURING TECHNOLOGIES	174
<i>Elias Ribeiro Da Silva, Ana Carolina Shinohara, Christian Petersson Nielsen, Edson Pinheiro De Lima, Jannis Angelis</i>	

CYBER-MANUFACTURING SYSTEM TESTBED DEVELOPMENT: ADVERSARIAL INSIDER MANIPULATION	180
<i>Jinwoo Song, Chunxi Wang, Charlélie Saudrais, Matthew K Swanson, Young B. Moon</i>	

CYBER-PHYSICAL SYSTEMS AND PRODUCTION CHARACTERISTICS - CLASSIFICATION AND VISUALIZATION OF RELATIONSHIPS	186
<i>Benjamin Illmer, Michael Vielhaber</i>	

PRODUCTION PLANNING FOR COLLABORATING RESOURCES IN CYBER-PHYSICAL PRODUCTION SYSTEMS	192
<i>Michaela Krü, Ludwig Vogt, Christian Härdtlein, Stefan Schiele, Johannes Schilp</i>	

DIGITAL TWINS AND IOT

DIGITAL TWIN-DRIVEN SUPPLY CHAIN PLANNING	198
<i>Yuchen Wang, Xingzhi Wang, Ang Liu</i>	

PRODUCT MIX OPTIMIZATION MODEL FOR AN INDUSTRY 4.0- ENABLED MANUFACTURING-REMANUFACTURING SYSTEM	204
<i>Saleh Bagalagel, Waguih Elmaraghy</i>	

DIGITAL TWINS IN MANUFACTURING: AN ASSESSMENT OF DRIVERS, ENABLERS AND BARRIERS TO IMPLEMENTATION	210
<i>Anis Assad Neto, Fernando Deschamps, Elias Ribeiro Da Silva, Edson Pinheiro De Lima</i>	

VIRTUAL FACTORY: DIGITAL TWIN BASED INTEGRATED FACTORY SIMULATIONS.....	216
<i>Emre Yildiz, Charles Møller, Arne Bilberg</i>	
CREATION OF DIGITAL PRODUCTION TWINS FOR THE OPTIMIZATION OF VALUE CREATION IN SINGLE AND SMALL BATCH PRODUCTION	222
<i>Günther Schuh, Christoph Kelzenberg, Jan Wiese, Niklas Kessler</i>	
A DIGITAL TWIN REFERENCE FOR MASS PERSONALIZATION IN INDUSTRY 4.0.....	228
<i>Shohin Aheleroff, Ray Y. Zhong, Xun Xu</i>	
METHOD FOR DATA INVENTORY AND CLASSIFICATION	234
<i>Melina Massmann, Maurice Meyer, Maximilian Frank, Sebastian Von Enzberg, Roman Dumitrescu</i>	
DIGITAL TWIN: MULTI-DIMENSIONAL MODEL REDUCTION METHOD FOR PERFORMANCE OPTIMIZATION OF THE VIRTUAL ENTITY.....	240
<i>Ananda Chakraborti, Arttu Heininen, Kari T. Koskinen, Ville Lämsä</i>	
PRODUCT FAMILY DESIGN AND OPTIMIZATION: A DIGITAL TWIN-ENHANCED APPROACH.....	246
<i>Pai Zheng, Kendrik Yan Hong Lim</i>	
DIGITAL TWINS AND BLOCKCHAIN – PROOF OF CONCEPT.....	251
<i>Christian Petersson Nielsen, Elias Ribeiro Da Silva, Fei Yu</i>	
NEW APPROACH FOR DIGITAL FACTORY USING VIRTUAL REALITY TECHNOLOGY.....	256
<i>Fahmi Bellalouna</i>	
NEW APPROACH FOR INDUSTRIAL TRAINING USING VIRTUAL REALITY TECHNOLOGY	262
<i>Fahmi Bellalouna</i>	
QUALITATIVE AND QUANTITATIVE EVALUATION OF RECONFIGURING AN AUTOMATION SYSTEM USING DIGITAL TWIN.....	268
<i>Behrang Ashtari Talkhestani, Dominik Braun, Wolfgang Schloegl, Michael Weyrich</i>	
EFFICIENT GENERATION OF A DIGITAL TWIN USING OBJECT DETECTION FOR DATA ACQUISITION AND XML-INTERFACE FOR MODEL CREATION.....	274
<i>Berend Denkena, Marc-André Dittrich, Sebastian Stobrawa, Josip Stjepandic</i>	
APPROACH FOR AN UPDATE METHOD FOR DIGITAL FACTORY MODELS	280
<i>René Hellmuth, Florian Wehner, Alexandros Giannakidis</i>	
MEASURES FOR A SUCCESSFUL DIGITAL TRANSFORMATION OF SMES	286
<i>Volker Stich, Violetta Zeller, Jan Hicking, Andreas Kraut</i>	
DIGITAL LIFECYCLE RECORDS AS AN INSTRUMENT FOR INTER-COMPANY KNOWLEDGE MANAGEMENT.....	292
<i>David Kiklhorn, Michael Wolny, Maximilian Austerjost, Alexander Michalik</i>	
EVALUATION OF END-TO-END PROCESS AND INFORMATION FLOW ANALYSES THROUGH DIGITAL TRANSFORMATION IN MECHANICAL ENGINEERING	298
<i>Thomas Pschybilla, Alex Homann</i>	

THE DIGITAL SHADOW: DEVELOPING A UNIVERSAL MODEL FOR THE AUTOMATED OPTIMIZATION OF CYBER-PHYSICAL PRODUCTION SYSTEMS BASED ON REAL-TIME DATA.....	304
<i>Jonas M. Ehrhardt, Christoph T. Hoffmann</i>	

DIGITAL SHOP FLOOR MANAGEMENT: A TARGET STATE.....	311
<i>Alyssa Meißner, Felix Grunert, Joachim Metternich</i>	

FACTORIES & SYSTEMS

DESIGNING DECISION-MAKING AUTHORITIES FOR SMART FACTORIES.....	316
<i>Oliver Antons, Julia C. Arlinghaus</i>	

TOWARDS LIVING MANUFACTURING SYSTEMS.....	323
<i>László Monostori, József Váncza</i>	

ULTRA-FLEXIBLE FACTORIES: AN APPROACH TO MANAGE COMPLEXITY.....	329
<i>Jörg Siegert, Thilo Schlegel, Liliana Zarco, Borislav Miljanovic, Thomas Bauernhansl</i>	

SEMANTIC STRUCTURING OF ELEMENTS AND CAPABILITIES IN ULTRA-FLEXIBLE FACTORIES.....	335
<i>Thomas Bauernhansl, Michael Weyrich, Liliana Zarco, Timo Müller, Jörg Siegert</i>	

CONCEPT FOR THE COMPARISON OF INTRALOGISTICS DESIGNS WITH REAL FACTORY LAYOUT USING AUGMENTED REALITY, SLAM AND MARKER-BASED TRACKING.....	341
<i>Anke Rohacz, Stefan Weißenfels, Steffen Strassburger</i>	

A CONCEPTUAL MODEL FOR MULTI-AGENT COMMUNICATION APPLIED ON A PLUG & PRODUCE SYSTEM.....	347
<i>Mattias Bennulf, Fredrik Danielsson, Bo Svensson</i>	

DESCRIPTION MODEL FOR THE ASSESSMENT OF AUTONOMOUS PRODUCTION STAGES.....	353
<i>Angelika Styr, Simon Schumacher, Dennis Bauer, Dominik Lucke, Thomas Bauernhansl</i>	

A MODEL-BASED AND SOFTWARE-ASSISTED SAFETY ASSESSMENT CONCEPT FOR RECONFIGURABLE PNP-SYSTEMS.....	359
<i>C. H. Koo, S. Schröck, M. Vorderer, J. Richter, A. Verl</i>	

DESIGN PARAMETERS FOR SMART MANUFACTURING INNOVATION PROCESSES.....	365
<i>Maria Stoettrup Schioenning Larsen, Astrid Heidemann Lassen</i>	

ASSESSMENT OF SMART MANUFACTURING SOLUTIONS BASED ON EXTENDED VALUE STREAM MAPPING.....	371
<i>Niels L. Martin, Antal Déz, Christoph Herrmann, Sebastian Thiede</i>	

MACHINE LEARNING

RECOGNITION OF CAR PARTS IN AUTOMOTIVE SUPPLY CHAINS BY COMBINING SYNTHETICALLY GENERATED TRAINING DATA WITH CLASSICAL AND DEEP LEARNING BASED IMAGE PROCESSING.....	377
<i>Axel Börold, Michael Teucke, Johannes Rust, Michael Freitag</i>	

DEEP REINFORCEMENT LEARNING-BASED DYNAMIC SCHEDULING IN SMART MANUFACTURING.....	383
<i>Longfei Zhou, Lin Zhang, Berthold K. P. Horn</i>	
A GENETIC ALGORITHM-BASED MODEL FOR PRODUCT PLATFORM DESIGN FOR HYBRID MANUFACTURING.....	389
<i>Mostafa Moussa, Hoda Elmaraghy</i>	
MUTUALISTIC AND ADAPTIVE HUMAN-MACHINE COLLABORATION BASED ON MACHINE LEARNING IN AN INJECTION MOULDING MANUFACTURING LINE	395
<i>Andrea Bettoni, Elias Montini, Massimiliano Righi, Valeria Villani, Emanuele Carpanzano</i>	
STREAMLINING THE DEVELOPMENT OF DATA-DRIVEN INDUSTRIAL APPLICATIONS BY AUTOMATED MACHINE LEARNING	401
<i>Dominik Kießkalt, Andreas Mayr, Benjamin Lutz, Annelie Rögele, Jörg Franke</i>	
MACHINE-LEARNING-BASED APPROACH FOR PARAMETERIZING MATERIAL FLOW SIMULATION MODELS.....	407
<i>Kilian Vernickel, Laura Brunner, Georg Hoellthaler, Giuseppe Sansivieri, Julia Berg</i>	
SYSTEMATIC REVIEW ON MACHINE LEARNING (ML) METHODS FOR MANUFACTURING PROCESSES – IDENTIFYING ARTIFICIAL INTELLIGENCE (AI) METHODS FOR FIELD APPLICATION.....	413
<i>Simon Fahle, Christopher Prinz, Bernd Kuhlenkötter</i>	
USING AI TO FACILITATE TECHNOLOGY MANAGEMENT – DESIGNING AN AUTOMATED TECHNOLOGY RADAR.....	419
<i>Günther Schuh, Jan Hicking, Max-Ferdinand Stroh, Justus Benning</i>	
MULTI-OBJECTIVE ADJUSTMENT OF REMAINING USEFUL LIFE PREDICTIONS BASED ON REINFORCEMENT LEARNING.....	425
<i>Dominik Kozjek, Andreja Malus, Rok Vrabic</i>	
APPLICATION OF MACHINE LEARNING FOR PRODUCT BATCH ORIENTED CONTROL OF PRODUCTION PROCESSES	431
<i>Moritz Meiners, Andreas Mayr, Maximilian Thomsen, Jörg Franke</i>	
DISTRIBUTED COOPERATIVE DEEP TRANSFER LEARNING FOR INDUSTRIAL IMAGE RECOGNITION.....	437
<i>Benjamin Maschler, Simon Kamm, Nasser Jazdi, Michael Weyrich</i>	
AUTOMATED MACHINE LEARNING FOR PREDICTIVE QUALITY IN PRODUCTION.....	443
<i>Jonathan Krauß, Bruno Machado Pacheco, Hanno Maximilian Zang, Robert Heinrich Schmitt</i>	
DATA-DRIVEN ANALYSIS OF PRODUCT STATE PROPAGATION IN MANUFACTURING SYSTEMS USING VISUAL ANALYTICS AND MACHINE LEARNING	449
<i>Marc-André Filz, Sebastian Gellrich, Christoph Herrmann, Sebastian Thiede</i>	
A MACHINE LEARNING APPROACH FOR IMPROVED SHOP-FLOOR OPERATOR SUPPORT USING A TWO-LEVEL COLLABORATIVE FILTERING AND GAMIFICATION FEATURES.....	455
<i>Nikolaos Nikolakis, George Siaterlis, Kosmas Alexopoulos</i>	
MACHINE LEARNING BASED ANALYSIS OF FACTORY ENERGY LOAD CURVES WITH FOCUS ON TRANSITION TIMES FOR ANOMALY DETECTION	461
<i>Dominik Flick, Claudio Keck, Christoph Herrmann, Sebastian Thiede</i>	

A PRACTICAL TRAINING APPROACH IN LEARNING FACTORIES TO MAKE ARTIFICIAL INTELLIGENCE TANGIBLE	467
<i>Henning Oberc, Simon Fahle, Christopher Prinz, Bernd Kuhlenkötter</i>	
DEVELOPMENT OF A NEW MACHINE LEARNING-BASED INFORMATICS SYSTEM FOR PRODUCT HEALTH MONITORING	473
<i>Moschos Papananias, Olusayo Obajemu, Thomas E McLeay, Mahdi Mahfouf, Visakan Kadiramanathan</i>	
IMPROVED FASTER R-CNN ALGORITHM FOR DEFECT DETECTION IN POWERTRAIN ASSEMBLY LINE.....	479
<i>Xu Liyun, Li Boyu, Mi Hong, Lu Xingzhong</i>	
MACHINE LEARNING METHODS FOR PREDICTION OF CHANGES IN MATERIAL FLOW NETWORKS.....	485
<i>Till Becker, Thorben Funke</i>	
BIG DATA CURATION FOR ANALYTICS WITHIN THE CYBER-PHYSICAL MANUFACTURING METROLOGY MODEL (CPM3).....	491
<i>Ramin Sabbagh, Brian Gawlik, S. V. Sreenivasan, A. Stothert, D. Djurdjanovic</i>	
<u>MANUFACTURING PROCESSES & DESIGN</u>	
A GRAPH-BASED APPROACH TO MANAGE CAE DATA IN A DATA LAKE.....	496
<i>Julian Ziegler, Peter Reimann, Florian Keller, Bernhard Mitschang</i>	
FORMING CHALLENGES OF EXTRUDED WOOD PLASTIC COMPOSITE PRODUCTS IN A POST-PRODUCTION PROCESS	502
<i>Amir Toghyani, Sami Matthews, Juha Varis</i>	
OBJECT LOCALIZATION UTILIZING 3D POINT CLOUD CLUSTERING APPROACH	508
<i>Gergely Horváth, Gábor Erdos</i>	
DIGITAL PROCESS MANAGEMENT FOR THE INTEGRATED BENDING OF THERMOPLASTIC CFRP TAPES	514
<i>Daniel Kupzik, Junsheng Ding, Sven Coutandin, Jürgen Fleischer</i>	
SIMULATION OF KINEMATIC HARDENING MODEL FOR CARBON STEEL AISI 1035 WELD STRESS PREDICTION DURING THE WELDING ASSEMBLY OF A RAILCAR	520
<i>Ilesanmi Daniyan, Khumbulani Mpofu, Festus Fameso, Felix Ale</i>	
OPTIMISATION OF ULTRASONICALLY WELDED JOINTS THROUGH MACHINE LEARNING.....	527
<i>P. G. Mongan, E. P. Hinchy, N. P. O'Dowd, C. T. McCarthy</i>	
A GRAPHICAL TOOLKIT FOR IEC 62264-2.....	532
<i>Laurens Lang, Bernhard Wally, Christian Huemer, Radek Šindelár, Manuel Wimmer</i>	
MODEL-BASED DESIGN OF ENERGY-EFFICIENT VACUUM-BASED HANDLING PROCESSES	538
<i>Felix Gabriel, Paul Bobka, Klaus Dröder</i>	
EXTRACTING SHAPE FEATURES FROM A SURFACE MESH USING GEOMETRIC REASONING.....	544
<i>Torbjørn Langedahl Leirmo, Oleksandr Semeniuta, Ivanna Baturynska, Kristian Martinsen</i>	

SIMULATION OF THE AIRFRAME ASSEMBLY PROCESS WITH REGARD TO FRICTION IN FASTENING ELEMENTS.....	550
<i>Sergey Lupuleac, Margarita Petukhova, Julia Shinder, Maria Churilova, Elodie Bonhomme</i>	
USING COMPONENT-BASED SOFTWARE SYNTHESIS AND CONSTRAINT SOLVING TO GENERATE SETS OF MANUFACTURING SIMULATION MODELS.....	556
<i>Fadil Kallat, Carina Mieth, Jakob Rehof, Anne Meyer</i>	
FUNCTION-OPTIMISED GENERATION OF AN ADAPTED TARGET MODEL FOR MECHANICAL RE-CONTOURING OF FAN BLADES	562
<i>Berend Denkena, Volker Böß, Marc-André Dittrich, Robert Kenneweg</i>	
USING FINITE ELEMENT ANALYSIS TO DEVELOP A DIGITAL TWIN OF A MANUFACTURING BENDING OPERATION.....	568
<i>E. P. Hinchy, C. Carcagno, N. P. O’Dowd, C. T. McCarthy</i>	
THE DIGITIZATION OF DESIGN AND MANUFACTURING: A STATE-OF-THE-ART REPORT ON THE TRANSITION FROM STRATEGIC VISION TO IMPLEMENTATION IN INDUSTRY	575
<i>Jelena Milisavljevic-Syed, J. Lane Thames, Dirk Schaefer</i>	
INFLUENCE OF BASEPLATE HEATING AND SHIELDING GAS ON DISTORTION, MECHANICAL AND CASE HARDENING PROPERTIES OF 16MNCR5 FABRICATED BY LASER POWDER BED FUSION	581
<i>Matthias Schmitt, Bernhard Kempter, Syed Inayathulla, Albin Gottwalt, Gunther Reinhart</i>	
 <u>MANUFACTURING SYSTEMS</u>	
HELPING COMPANIES TO EVALUATE THEIR STATUS QUO IN INFORMATION SECURITY WITH A SERIOUS GAMING-BASED ECONOMICAL QUANTIFICATION APPROACH.....	587
<i>Günther Schuh, Jan Hicking, Jacques Engländer, Violett Zeller, Martin Perau</i>	
TRUST-DRIVEN VEHICLE PRODUCT-SERVICE SYSTEM: A BLOCKCHAIN APPROACH.....	593
<i>Xingzhi Wang, Yuchen Wang, Ang Liu</i>	
OUTCOME ECONOMY: SUBSCRIPTION BUSINESS MODELS IN MACHINERY AND PLANT ENGINEERING	599
<i>Günther Schuh, Lucas Wenger, Volker Stich, Jan Hicking, Jonas Gailus</i>	
INTEGRATING SUSTAINABILITY CONSIDERATIONS INTO PRODUCT VARIETY AND PORTFOLIO MANAGEMENT	605
<i>Khaled Medini, Thorsten Wuest, David Romero, Valérie Laforest</i>	
TRADITIONAL AND ACTIVITY BASED AGGREGATE JOB COSTING MODEL	610
<i>Darwish Alami, Waguih Elmaraghy</i>	
AFFORDABLE DATA INTEGRATION APPROACH FOR PRODUCTION ENTERPRISES.....	616
<i>David Sanderson, Jack C. Chaplin, Svetan Ratchev</i>	
USING CONTEXT DATA TO IMPROVE THE OVERALL PRODUCT QUALITY IN PROCESS CHAINS	622
<i>Jürgen Henke, Dominik Lucke, Hartmut Eigenbrod</i>	

AN APPROACH TO ANALYZE THE PERFORMANCE OF ADVANCED MANUFACTURING ENVIRONMENT.....	628
<i>Kashif Mahmood, Tauno Otto, Tavo Kangru, Vladimir Kuts</i>	
METROLOGICAL PPC: DETERMINATION OF ADDED-VALUE DRIVEN MODULE PROCESS GRAPHS	634
<i>Thilo Schlegel, Jörg Siegert, Tobias Mahr, Liliana Zarco, Thomas Bauernhansl</i>	
LOGISTIC DECISIONS IN VALUE STREAM DESIGN: A CASE STUDY	640
<i>Joscha Kaiser, Sarah Zimmermann, Joachim Metternich</i>	
REFERENCE ARCHITECTURE FOR THE INDUSTRIAL IMPLEMENTATION OF ZERO-DEFECT MANUFACTURING STRATEGIES	646
<i>Maria Chiara Magnanini, Marcello Colledani, Davide Caputo</i>	
POTENTIALS OF PLATFORMS FOR THE REALIZATION OF DIGITAL SERVICES FOR COMPONENT MANUFACTURERS	652
<i>Dimitri Petrik, David Straub, Georg Herzwurm</i>	
MANUFACTURING SYSTEM OPTIMIZATION WITH LEAN METHODS, MANUFACTURING PROCESS OBJECTIVES AND FUZZY LOGIC CONTROLLER DESIGN	658
<i>Tom Drews, Paul Molenda, Oliver Oechsle, Jan Koller</i>	
BACKLOG-SEQUENCING: A COMPARISON BETWEEN WORKLOAD CONTROL AND CONWIP USING A SIMULATION APPROACH	664
<i>Paul Molenda, Tizian Mezger, Oliver Oechsle, Jan Koller, Frank Döpfer</i>	
HUMAN-CENTERED GAMIFICATION FRAMEWORK FOR MANUFACTURING SYSTEMS.....	670
<i>Jessica Ulmer, Sebastian Braun, Chi-Tsun Cheng, Steve Dowey, Jörg Wollert</i>	
A TOOL FOR HOLISTIC ASSESSMENT OF DIGITALIZATION CAPABILITIES IN MANUFACTURING SMES.....	676
<i>Britta Ottessjö, Sandra Nyström, Daniel Näfors, Jonatan Berglund, Per Gullander</i>	
MODELING AND ASSESSING THE EFFECTS OF DIGITAL TECHNOLOGIES ON KPIS IN MANUFACTURING SYSTEMS	682
<i>Carina Siedler, Pascal Langlotz, Jan C. Aurich</i>	
CONSTRUCTION OF A VIRTUAL SUPPLY CHAIN USING ENTERPRISE E-CATALOGUES.....	688
<i>Michiko Matsuda, Tatsushi Nishi, Mao Hasegawa, Takuto Terunuma</i>	
COMPLEXITY ASSESSMENT IN PRODUCTION: LINKING COMPLEXITY DRIVERS AND EFFECTS	694
<i>Boris Brinzer, Konstanze Schneider</i>	
PRODUCT TRACEABILITY IN MANUFACTURING: A TECHNICAL REVIEW.....	700
<i>Reuben Schuitemaker, Xun Xu</i>	
TOWARDS INCREASING ROBUSTNESS IN GLOBAL PRODUCTION NETWORKS BY MEANS OF AN INTEGRATED DISRUPTION MANAGEMENT	706
<i>Sina Peukert, Jonas Lohmann, Benjamin Haefner, Gisela Lanza</i>	
LEAN PRINCIPLES IN VERTICAL FARMING: A CASE STUDY.....	712
<i>Francis Baumont De Oliveira, Hannah Forbes, Dirk Schaefer, Jelena Milisavljevic Syed</i>	

PROCESS MAPPING IN INDUSTRY – THE SELF-CENTRED PHENOMENON AND HOW IT EFFECTS CONTINUOUS IMPROVEMENTS	718
<i>Anders Johansson, Mariam Nafisi</i>	
A FRAMEWORK FOR DESIGNING DATA PIPELINES FOR MANUFACTURING SYSTEMS	724
<i>Omogbai Oleghe, Konstantinos Salonitis</i>	
USING SMART SERVICES AS A KEY ENABLER FOR COLLABORATION IN GLOBAL PRODUCTION NETWORKS	730
<i>Florian Stamer, Martin Steinke, Rainer Silbernagel, Benjamin Häfner, Gisela Lanza</i>	
HOW CURRENT TRENDS IN MECHANICAL ENGINEERING CAN SHAPE INTERORGANIZATIONAL R&D	736
<i>Marc Wiedenmann, Simon Dreher, Philipp Humbeck, Oliver Schöllhammer, Thomas Bauernhansl</i>	
TEMPORAL ANALYSIS OF EVENT-DISCRETE ALARM DATA FOR IMPROVED MANUFACTURING	742
<i>Heiner Reinhardt, Jan-Peter Bergmann, Anke Stoll, Matthias Putz</i>	
INCORPORATING ECONOMIC ASPECTS INTO RECOMMENDATION RANKING TO REDUCE FAILURE COSTS	747
<i>Vitali Hirsch, Peter Reimann, Bernhard Mitschang</i>	
TOWARDS A RISK-ORIENTED SMART PSS ENGINEERING FRAMEWORK	753
<i>Camilo Murillo Coba, Xavier Boucher, Jesus Gonzalez-Feliu, François Vuillaume, Alexandre Gay</i>	
ROBUSTNESS AS ENABLER FOR SUSTAINABLE PRODUCTION NETWORKS.....	759
<i>Ann-Kathrin Onken, Annika Schiemenz, Alexander Bader, Kirsten Tracht</i>	
FREQUENCY RESPONSE ANALYSIS OF INVENTORY VARIATION IN PRODUCTION NETWORKS WITH INFORMATION SHARING	765
<i>Neil Duffie, Michael Freitag</i>	
A FRAMEWORK FOR MANAGING INNOVATION CYCLES IN MANUFACTURING SYSTEMS	771
<i>Andreas Hofer, Felix Brandl, Harald Bauer, Sajedeh Haghi, Gunther Reinhart</i>	
SIMULATION-BASED ASSESSMENT OF QUALITY INSPECTION STRATEGIES ON MANUFACTURING SYSTEMS	777
<i>Marc-André Filz, Christoph Herrmann, Sebastian Thiede</i>	

PART 2

THE IMPACT OF THE DIGITAL TRANSFORMATION ON LEAN PRODUCTION SYSTEMS	783
<i>Simon Schumacher, Andreas Bildstein, Thomas Bauernhansl</i>	
DATABASED PRODUCT ADJUSTMENTS DURING MANUFACTURING BASED ON AGILE PRODUCTION AND DIGITAL REPRESENTATION IN SHIPBUILDING PREFABRICATION	789
<i>Konrad Jagusch, Jan Sender, Wilko Flügge</i>	
APPROACHING DYNAMIC AND INDIVIDUAL WORKER INFORMATION SYSTEMS.....	795
<i>Severin Teubner, Christoph Rimpau, Gunther Reinhart</i>	

TOWARD THE DEVELOPMENT OF A COMPREHENSIVE PRODUCT-SERVICE SYSTEM (PSS) EVALUATION METHOD.....	802
<i>Takehiko Nakada, Mar'Atus Sholihah, Yuya Mitake, Yoshiki Shimomura</i>	
BEYOND THE PROFIT MOTIVE: ENVIRONMENTALLY CONSCIOUS (RE)DESIGN OF SUPPLY CHAIN STRUCTURES	808
<i>Judit Monostori</i>	
PROCEDURE MODEL FOR THE IMPLEMENTATION OF AN ORDER RELEASE METHOD.....	814
<i>Christian Ortmeier, Uwe Dombrowski</i>	
CORPORATE LEAN PROGRAMS: PRACTICAL INSIGHTS AND IMPLICATIONS FOR LEARNING AND CONTINUOUS IMPROVEMENT	820
<i>Daryl Powell, Paul Coughlan</i>	
APPROACH TO VALUE STREAM MAPPING FOR MAKE-TO-ORDER MANUFACTURING	826
<i>Devanshu Mudgal, Emanuele Pagone, Konstantinos Salonitis</i>	
DEVELOPMENT OF A CATALOGUE OF CRITERIA FOR THE EVALUATION OF THE SELF-ORGANIZATION OF FLEXIBLE INTRALOGISTICS SYSTEMS	832
<i>Jan Schuhmacher, Vera Hummel</i>	
CAN WE ADOPT THE TOYOTA KATA FOR THE (RE-)DESIGN OF BUSINESS PROCESSES IN THE COMPLEX ENVIRONMENT OF A MANUFACTURING COMPANY?.....	838
<i>Felix J. Brandl, Kevin S. Ridolfi, Gunther Reinhart</i>	
FUTURE SCENARIOS OF VALUE CREATION IN MECHANICAL ENGINEERING – DERIVATION OF RECOMMENDATIONS FOR ACTION	844
<i>Philipp Humbeck, Siegfried Mangold, Thomas Bauernhansl</i>	
 <u>METAL CUTTING AND MACHINE TOOLS</u> 	
IMPROVING DYNAMIC PROCESS STABILITY IN MILLING OF THIN-WALLED WORKPIECES BY OPTIMIZATION OF SPINDLE SPEED BASED ON A LINEAR PARAMETER-VARYING MODEL	850
<i>Semir Maslo, Bruno Menezes, Pascal Kienast, Philipp Ganser, Thomas Bergs</i>	
CHATTER STABILITY PREDICTION FOR MULTI-ROBOTS COLLABORATIVE MILLING SYSTEM.....	856
<i>Xiong Zhao, Lianyu Zheng, Xinyu Liu, Yansheng Cao</i>	
ENERGY PREDICTION IN PROCESS PLANNING OF FIVE-AXIS MACHINING BY DATA-DRIVEN MODELLING	862
<i>V. S. Vishnu, Kiran George Varghese, B. Gurumoorthy</i>	
A SENSOR FRAMEWORK FOR COMBINED DATA STREAMS AND IN-SITU CHARACTERIZATION OF MACHINING PROCESSES.....	868
<i>Darya Botkina, Bernd Peukert, Tilman Gebhard, Benedikt Schwarz, Thomas Lundholm</i>	
PREPARATION OF SYMMETRICAL AND ASYMMETRICAL CUTTING EDGES ON SOLID CUTTING TOOLS USING BRUSHING TOOLS WITH FILAMENT-INTEGRATED DIAMOND GRITS	873
<i>T. Bergs, S. A. M. Schneider, M. Amara, P. Ganser</i>	

VARIATION COMPENSATION IN MACHINING PROCESSES USING DUAL QUATERNIONS.....	879
<i>Filmon Yacob, Daniel Semere</i>	

PLANNING, SCHEDULING & MAINTENANCE

DATABASED PREDICTION AND PLANNING OF ORDER-SPECIFIC TRANSITION TIMES.....	885
<i>Günther Schuh, Andreas Gützlaff, Frederick Saueremann, Oliver Kaul, Nicolas Klein</i>	

PERFORMANCE ASSESSMENT METHODOLOGY FOR AI-SUPPORTED DECISION-MAKING IN PRODUCTION MANAGEMENT	891
<i>Peter Burggräf, Johannes Wagner, Benjamin Koke, Milan Bamberg</i>	

APPLICATION OF TIME SERIES DATA MINING FOR THE PREDICTION OF TRANSITION TIMES IN PRODUCTION	897
<i>Günther Schuh, Andreas Gützlaff, Frederick Saueremann, Theresa Theunissen</i>	

IDENTIFICATION OF THE CRITICAL REACTION TIMES FOR RE-SCHEDULING FLEXIBLE JOB SHOPS FOR DIFFERENT TYPES OF UNEXPECTED EVENTS	903
<i>Foivos Psarommatis, Ali Gharaei, Dimitris Kiritsis</i>	

A METHOD FOR IMPLEMENTATION OF MACHINE LEARNING SOLUTIONS FOR PREDICTIVE MAINTENANCE IN SMALL AND MEDIUM SIZED ENTERPRISES	909
<i>Rebecca Welte, Manfred Estler, Dominik Lucke</i>	

DYNAMIC RISK CONSIDERATION OF PREDICTED MAINTENANCE NEEDS REGARDING ECONOMIC EFFICIENCY	915
<i>Fabian Foerster, Lukas Nickelowski</i>	

USER-CENTERED EVALUATION OF AN AUGMENTED REALITY-BASED ASSISTANCE SYSTEM FOR MAINTENANCE	921
<i>Moritz Quandt, Thies Beinke, Michael Freitag</i>	

COMBINED DESIGN AND PROCESS PLANNING FOR INCREMENTAL MANUFACTURING.....	927
<i>Ann-Kathrin Reichler, Julian Redeker, Felix Gabriel, Fabio Kai Falke, Klaus Dröder</i>	

A PROPOSED PRODUCTION DECISION METHOD FOR ORDER PLANNING CONSIDERING DECISION CRITERIA OF MULTIPLE ORGANIZATIONS	933
<i>Daisuke Kokuryo, Ken Yamashita, Toshiya Kaihara, Nobutada Fujii, Rihito Izutsu</i>	

A MUTUALISTIC FRAMEWORK FOR SUSTAINABLE CAPACITY SHARING IN MANUFACTURING	938
<i>Ádám Szaller, Gianfranco Pedone, Péter Egri, Ádám Szalóki, Gábor Nick</i>	

THE INSUFFICIENCY OF LEAN TRADITION – LEAN MEETS KODAK MOMENTS	944
<i>Halvor Holtskog, Geir Ringen</i>	

INTEGRATION OF PRODUCTION SCHEDULING AND GROUP MAINTENANCE PLANNING IN MULTI-UNIT SYSTEM EMPLOYING TLBO ALGORITHM.....	949
<i>Aseem K. Mishra, Divya Shrivastava</i>	

LEAN MAINTENANCE AND REPAIR IMPLEMENTATION - A CROSS-CASE STUDY OF SEVEN AUTOMOTIVE SERVICE SUPPLIERS.....	955
<i>Julia C. Arlinghaus, Stephanie Knizkov</i>	

DATA-DRIVEN PRODUCT GENERATION AND RETROFIT PLANNING.....	965
<i>Maurice Meyer, Maximilian Frank, Melina Massmann, Niklas Wendt, Roman Dumitrescu</i>	
A DATA-DRIVEN APPROACH FOR DECISION-MAKING SUPPORT OF FACTORY SIMULATION SOLUTIONS	971
<i>Fei Yu, Christian P. Nielsen</i>	
A FRAMEWORK FOR AUTOMATIC GENERATION OF AUGMENTED REALITY MAINTENANCE & REPAIR INSTRUCTIONS BASED ON CONVOLUTIONAL NEURAL NETWORKS.....	977
<i>Dimitris Mourtzis, John Angelopoulos, Nikolaos Panopoulos</i>	
DEFINITION OF PROBLEM TYPES FOR PLANNING DIGITALLY SUPPORTED PROBLEM- SOLVING PROCESSES DURING PRODUCTION LAUNCH	983
<i>Maximilian Meister, Joachim Metternich, Amir Cviko</i>	
A FRAMEWORK FOR ADAPTIVE SCHEDULING IN CELLULAR MANUFACTURING SYSTEMS	989
<i>D. Mourtzis, V. Siatras, G. Synodinos, J. Angelopoulos, N. Panopoulos</i>	
INTEGRATED DISASSEMBLY AND ASSEMBLY MODEL FOR HEAVY DUTY EQUIPMENT MAINTENANCE.....	995
<i>Kai Kang, Ray Y. Zhong, Aydin Nassehi</i>	
STEEL PLATE SCHEDULING OPTIMIZATION IN SHIPBUILDING BASED ON STORAGE AREA PARTITION	1001
<i>Xu Liyun, Shu Zhongyu, Yang Liansheng</i>	
ENERGY-AWARE SCHEDULING IN RECONFIGURABLE MULTIPLE PATH SHOP FLOORS.....	1007
<i>Damien Lamy, Julia Schulz, Michael F. Zaeh</i>	
DESIGN MODEL FOR A VALUE CHAIN-ORIENTED QUALITY MANAGEMENT IN GLOBAL TOOLING	1013
<i>Thomas Bergs, Marcel Prümmer, Christian Lürken, Kristian Arntz</i>	
IDENTIFICATION OF UNINTENDED EFFECTS CAUSED BY ADAPTATIONS OF MANUFACTURING PROCESS SEQUENCES FOR SAFETY-CRITICAL COMPONENTS.....	1019
<i>T. Bergs, L. Hermann, J. Rey, S. Barth</i>	
UNSUPERVISED LEARNING FOR OPPORTUNISTIC MAINTENANCE OPTIMIZATION IN FLEXIBLE MANUFACTURING SYSTEMS	1025
<i>Michael Wocker, Naomi Kimberly Betz, Christian Feuersänger, Alexander Lindworsky, Jochen Deuse</i>	
DIGITAL ASSISTANCE SYSTEM FOR TARGET DATE PLANNING IN THE INITIATION PHASE OF LARGE-SCALE PROJECTS	1031
<i>Benjamin Illgen, Jan Sender, Wilko Flügge</i>	
A PERFORMANCE MEASUREMENT SYSTEM FOR INTEGRATED PRODUCTION AND MAINTENANCE PLANNING	1037
<i>M. Schreiber, C. S. L. Schutte, S. Braunreuther, G. Reinhart</i>	

ROBOTIC AND ASSEMBLY SYSTEMS

A PARTICIPATORY RESEARCH APPROACH FOR STUDYING THE DESIGN PROCESS OF FLEXIBLE ASSEMBLY SYSTEMS	1043
<i>Natalia Svensson Harari, Anders Fundin, Anna-Lena Carlsson</i>	
DATA-DRIVEN AND AR ASSISTED INTELLIGENT COLLABORATIVE ASSEMBLY SYSTEM FOR LARGE-SCALE COMPLEX PRODUCTS.....	1049
<i>Xinyu Liu, Lianyu Zheng, Jiazhou Shuai, Renjie Zhang, Yun Li</i>	
DATA-DRIVEN MODELS FOR FAULT CLASSIFICATION AND PREDICTION OF INDUSTRIAL ROBOTS	1055
<i>Corbinian Nentwich, Sebastian Junker, Gunther Reinhart</i>	
SKILL-BASED PROGRAMMING OF FORCE-CONTROLLED ASSEMBLY TASKS USING DEEP REINFORCEMENT LEARNING	1061
<i>Arik Lämmle, Thomas König, Mohamed El-Shamouty, Marco F. Huber</i>	
HARDWARE-IN-THE-LOOP BASED SIMULATION OF SAFETY REACTION TIMES AT THE EXAMPLE OF A STÄUBLI ROBOT CELL	1067
<i>Stefan Trabesinger, Rudolf Pichler, Michael Pichler, Florian Payerl, Andreas Ettinger</i>	
MODELING AND EVALUATING AGILE ASSEMBLY SYSTEMS USING MIXED-INTEGER LINEAR PROGRAMMING	1073
<i>Peter Burggräf, Matthias Dannapfel, Tobias Adlon, Esben Schukat, Lucian Holtwiesche</i>	
DETERMINING AND EVALUATING TRAJECTORIES OF A MODULAR MACHINE END-EFFECTOR IN A MANUFACTURING ENVIRONMENT USING A GAME ENGINE.....	1079
<i>Liliana Zarco, Jörg Siegert, Thilo Schlegel, Thomas Bauernhansl</i>	
A HUMAN-ROBOT COLLABORATION SYSTEM TOWARDS HIGH ACCURACY	1085
<i>Xi Vincent Wang, Xuetao Zhang, Ying Yang, Lihui Wang</i>	
AUTOMATED SCENARIO ANALYSIS OF REINFORCEMENT LEARNING CONTROLLED LINE-LESS ASSEMBLY SYSTEMS	1091
<i>Amon Göppert, Jonas Rachner, Robert H. Schmitt</i>	
AN ONTOLOGY FOR HUMAN-ROBOT COLLABORATION.....	1097
<i>Alessandro Umbrico, Andrea Orlandini, Amedeo Cesta</i>	
TOLERANCE MANAGEMENT IN ROBOT-BASED ASSEMBLY OPTIMIZES PRODUCT, PROCESS AND SYSTEM DEVIATIONS	1103
<i>Rainer Müller, Matthias Scholer, Leonie Schirmer, Anne Blum</i>	
ASSEMBLY TASK ANALYSIS USING THE GENERAL ASSEMBLY TASK MODEL (GATM) ON THE SHOP FLOOR	1109
<i>Sebastian Pimminger, Werner Kurschl, Lisa Panholzer, Thomas Neumayr, Johann Heinzlreiter</i>	
ACCURACY ANALYSIS OF ALIGNMENT METHODS BASED ON REFERENCE FEATURES FOR ROBOT-BASED OPTICAL INSPECTION SYSTEMS.....	1115
<i>Philipp Bauer, Fuyuan Li, Alejandro Magaña Flores, Gunther Reinhart</i>	
MULTI-STAGED, MULTI-OBJECTIVE OPTIMIZATION FOR OPERATION MANAGEMENT IN LINE-LESS MOBILE ASSEMBLY SYSTEMS (LMAS)	1121
<i>Armin F. Buckhorst, Robert H. Schmitt</i>	

CHANGEABILITY OF MATRIX ASSEMBLY SYSTEMS.....	1127
<i>Michael Trierweiler, Petra Foith-Förster, Thomas Bauernhansl</i>	
POSE ERROR CORRECTION OF A ROBOT END-EFFECTOR USING A 3D VISUAL SENSOR FOR CONTROL CABINET WIRING	1133
<i>Florian Hefner, Simon Schmidbauer, Jörg Franke</i>	
LIMP COMPONENT DESIGN FOR AUTOMATIC ASSEMBLY – CLASSIFICATION RATING SYSTEM AND DESIGN RULES	1139
<i>Jerome Trommnau, Alexander Neb, Cord Cordes, Andreas Frommknecht, Thomas Bauernhansl</i>	
PERSONALIZED WORK INSTRUCTION SYSTEM FOR REVITALIZING HUMAN- MACHINE INTERACTION.....	1145
<i>Daisuke Tsutsumi, Dávid Gyulai, Emma Takács, Júlia Bergmann, Kikuo Fujita</i>	
NOVEL APPROACH TO OPTIMIZATION OF FASTENER PATTERN FOR AIRFRAME ASSEMBLY PROCESS	1151
<i>Tatiana Pogarskaia, “ Sergey Lupuleac, Elodie Bonhomme</i>	
AN AGENT-BASED APPROACH TO PLANNING AND CONTROLLING ADAPTABLE CELL-ORIENTED ASSEMBLY SYSTEMS.....	1158
<i>Alexander Gaal, Klemens Hofer, Thomas Ryback, Lukas Lingitz, Wilfried Sihn</i>	
A STOCHASTIC APPROACH TO CALCULATE ASSEMBLY CYCLE TIMES BASED ON SPATIAL SHOP-FLOOR DATA STREAM.....	1164
<i>Júlia Bergmann, Dávid Gyulai, Dávid Morassi, József Váncza</i>	
HYBRID APPROACH TO AGILE ASSEMBLY PLANNING – EMPIRICAL EVALUATION OF THE INDUSTRIAL PRACTICE	1170
<i>Peter Burggräf, Matthias Dannapfel, Tobias Adlon, Carsten Fölling</i>	
OBJECTIVE DATA ACQUISITION AS THE BASIS OF DIGITIZATION IN MANUAL ASSEMBLY SYSTEMS.....	1176
<i>Martin Sudhoff, Stefan Leineweber, Matthias Linsinger, Jan Felix Niemeyer, Bernd Kuhlenkötter</i>	
INFORMATION PROVISION UTILIZING A DYNAMIC PROJECTION SYSTEM IN INDUSTRIAL SITE ASSEMBLY	1182
<i>Patrick Rupprecht, Hans Kueffner-McCauley, Sebastian Schlund</i>	
SYMBIOTIC HUMAN-ROBOT COLLABORATION: MULTIMODAL CONTROL USING FUNCTION BLOCKS	1188
<i>Sichao Liu, Lihui Wang, Xi Vincent Wang</i>	
A FRAMEWORK FOR REALIZING INDUSTRIAL HUMAN-ROBOT COLLABORATION THROUGH VIRTUAL SIMULATION	1194
<i>Niklas Land, Anna Syberfeldt, Torgny Almgren, Johan Vallhagen</i>	
ADVANCED HUMAN-ROBOT COLLABORATIVE ASSEMBLY USING ELECTROENCEPHALOGRAM SIGNALS OF HUMAN BRAINS	1200
<i>Abdullah Mohammed, Lihui Wang</i>	
CAPABILITY-BASED ASSEMBLY DESIGN: AN APPROACH FOR PLANNING AN AGILE ASSEMBLY SYSTEM IN AUTOMOTIVE INDUSTRY	1206
<i>Peter Burggräf, Matthias Dannapfel, Tobias Adlon, Hannes Kahmann, Julian Keens</i>	

INCREASING THE ROBUSTNESS OF RANDOM BIN PICKING BY AVOIDING GRASPS OF ENTANGLED WORKPIECES 1212
Marius Moosmann, Felix Spenrath, Kilian Kleeberger, Muhammad Usman Khalid, Richard Bormann

AN AUGMENTED REALITY FRAMEWORK FOR ROBOTIC TOOL-PATH TEACHING..... 1218
Sonia Mary Chacko, Armando Granado, Vikram Kapila

SENSING, PROCESS MONITORING AND CONTROL

IMAGE PROCESSING BASED ON DEEP NEURAL NETWORKS FOR DETECTING QUALITY PROBLEMS IN PAPER BAG PRODUCTION..... 1224
Anna Syberfeldt, Fredrik Vuoluterä

A VISION-BASED SYSTEM FOR REAL-TIME DEFECT DETECTION: A RUBBER COMPOUND PART CASE STUDY..... 1230
Panagiotis Stavropoulos, Alexios Papacharalampopoulos, Dimitris Petridis

EXPERIMENTAL INVESTIGATION OF RUBBER EXTRUSION PROCESS THROUGH VIBRATIONAL TESTING 1236
Alexios Papacharalampopoulos, Dimitris Petridis, Panos Stavropoulos

ARCHITECTURE FOR SIMULATION AND OPTIMIZATION OF ENERGY CONSUMPTION OF AUTOMATED PRODUCTION SYSTEMS 1241
Jannis Sinnemann, Matthias Bartelt, Anton Strahilov, Bernd Kuhlenkötter

AUTOMATED DATA LABELING AND ANOMALY DETECTION USING AIRBORNE SOUND ANALYSIS..... 1247
Matthias Mühlbauer, Hubert Würschinger, Dominik Polzer, Shu Ju, Nico Hanenkamp

AN INVESTIGATION UPON OVERHANG ZONES BY USING FINITE ELEMENT MODELLING AND IN-SITU MONITORING SYSTEMS 1253
Gokhan Dursun, Baris Pehlivanogullari, Cagdas Sen, Akin Orhangul

INTERACTION DESIGN FOR MULTI-USER VIRTUAL REALITY SYSTEMS: AN AUTOMOTIVE CASE STUDY 1259
Liang Gong, Henrik Söderlund, Leonard Bogojevic, Xiaoxia Chen, Björn Johansson

GEOMETRY AND TEMPERATURE DATA FUSION FOR AUTOMATED MEASUREMENT DURING OPEN DIE FORGING OF LARGE HOT WORKPIECES 1265
Gašper Škulj, Drago Bracun

HYBRID VIRTUAL ENERGY METERING POINTS – A LOW-COST ENERGY MONITORING APPROACH FOR PRODUCTION SYSTEMS BASED ON OFFLINE TRAINED PREDICTION MODELS 1269
Johannes Sossenheimer, Oliver Vetter, Eberhard Abele, Matthias Weigold

DETERMINATION OF SURFACE SHAPE DEVIATION BY USING FORCE-CONTROLLED BURNISHING 1275
Marco Posdzhich, Rico Stöckmann, Marco Witt, Matthias Putz

ANOMALY DETECTION IN FORMED SHEET METALS USING CONVOLUTIONAL AUTOENCODERS 1281
Jens Heger, Gururaj Desai, Mazhar Zein El Abdine

NATURALISTIC DRIVING STUDY FOR AUTOMATED DRIVER ASSISTANCE SYSTEMS (ADAS) EVALUATION IN THE CHINESE, SWEDISH AND AMERICAN MARKETS.....	1286
<i>Julia Orlovska, Casper Wickman, Rikard Söderberg</i>	
ICE DETECTION ON ROTOR BLADES OF WIND TURBINES USING RGB IMAGES AND CONVOLUTIONAL NEURAL NETWORKS.....	1292
<i>Markus Kreutz, Abderrahim Ait Alla, Anatoli Eisenstadt, Michael Freitag, Klaus-Dieter Thoben</i>	
AUGMENTED REALITY SMART GLASSES FOR OPERATORS IN PRODUCTION: SURVEY OF RELEVANT CATEGORIES FOR SUPPORTING OPERATORS.....	1298
<i>Oscar Danielsson, Magnus Holm, Anna Syberfeldt</i>	
PROCEDURE AND VALIDATION OF THE IMPLEMENTATION OF AUTOMATED SENSOR INTEGRATION KINEMATICS IN AN LPBF SYSTEM	1304
<i>Maximilian Binder, Christian Dirnhof, Philipp Kindermann, Max Horn, Gunther Reinhart</i>	
DEVELOPMENT OF A MONITORING SYSTEM FOR IMPLEMENTATION OF INDUSTRIAL DIGITALIZATION AND AUTOMATION USING 143 KEY PERFORMANCE INDICATORS.....	1310
<i>Andreas Schumacher, Wilfried Sihn</i>	
ONLINE VISION-BASED INSPECTION SYSTEM FOR THERMOPLASTIC HOT PLATE WELDING IN WINDOW FRAME MANUFACTURING	1316
<i>Pablo Martinez, Mohamed Al-Hussein, Rafiq Ahmad</i>	
QUALITY PREDICTION OF HONED BORES WITH MACHINE LEARNING BASED ON MACHINING AND QUALITY DATA TO IMPROVE THE HONING PROCESS CONTROL	1322
<i>Sven Klein, Sebastian Schorr, Dirk Bähre</i>	
IN-PROCESS QUALITY CONTROL OF DRILLED AND REAMED BORES USING NC-INTERNAL SIGNALS AND MACHINE LEARNING METHOD	1328
<i>Sebastian Schorr, Matthias Möller, Jörg Heib, Dirk Bähre</i>	
HARDWARE-IN-THE-LOOP SIMULATION FOR A DYNAMIC CO-SIMULATION OF INTERNET-OF-THINGS-COMPONENTS	1334
<i>Tobias Jung, Nasser Jazdi, Stefan Krauß, Christian Köllner, Michael Weyrich</i>	
UNDERSTANDING LIGHT. A STUDY ON THE PERCEIVED QUALITY OF CAR EXTERIOR LIGHTING AND INTERIOR ILLUMINATION	1340
<i>Kostas Styliadis, Anna Woxlin, Louise Siljefalk, Emelie Heimersson, Rikard Söderberg</i>	
COMBINING MULTIPLE DATA SOURCES AND ENRICHING THE DATASET USING INDUSTRIAL EDGE DEVICES.....	1346
<i>Stefan Dumss, Manfred Grafinger, Martin Hennig, Patrick Rosenberger</i>	
COMPARISON OF TIME SERIES CLUSTERING ALGORITHMS FOR MACHINE STATE DETECTION.....	1352
<i>Martin Hennig, Manfred Grafinger, Detlef Gerhard, Stefan Dumss, Patrick Rosenberger</i>	
<u>SYS+ CATEGORY</u>	
PRODUCTION PLANNING IN AUTONOMOUS AND MATRIX-STRUCTURED ASSEMBLY SYSTEMS: EFFECTS OF SIMILARITY OF PRECEDENCE GRAPHS ON ORDER RELEASE SEQUENCING	1358
<i>Daniel Mueller, Tanja V. Schmitt</i>	

THE ETHICAL USE OF HUMAN DATA FOR SMART MANUFACTURING: AN ANALYSIS
AND DISCUSSION 1364
Harley Oliff, Ying Liu, Maneesh Kumar, Michael Williams

YOUR CUSTOMER'S DIGITAL SHADOW – OBJECTIFICATION OF HUMAN PERCEPTION
BY A MULTISENSORY MEASUREMENT SYSTEM 1370
Lars C. Gussen, Max Ellerich, Robert H. Schmitt, Nikola Viktorov

SKILL MODELING IN CYBER-PHYSICAL PRODUCTION SYSTEMS FOR PROCESS
MONITORING 1376
Clemens Gonnermann, Johannes Weth, Gunther Reinhart

METAL CUTTING AND MACHINE TOOLS

AI-BASED APPROACH FOR PREDICTING THE MACHINABILITY UNDER
CONSIDERATION OF MATERIAL BATCH DEVIATIONS IN TURNING PROCESSES 1382
Benjamin Lutz, Dominik Kisskalt, Daniel Regulin, Jörg Franke

A UNIFIED APPROACH TOWARDS PERFORMANCE MONITORING AND CONDITION-
BASED MAINTENANCE IN GRINDING MACHINES 1388
Muhammad Ahmer, Pär Marklund, Martin Gustafsson, Kim Berglund

CNC MACHINING OF LARGE FRPC PARTS EMPLOYING WORKPIECE LOCALIZATION
AND TOOLPATH ADAPTATION 1394
Luka Selak, Omar Ashal, Drago Bracun

THE DEVELOPMENT OF A DIGITAL TWIN FOR MACHINING PROCESSES FOR THE
APPLICATION IN AEROSPACE INDUSTRY 1399
Albrecht Hänel, Thorben Schnellhardt, Eric Wenkler, Andreas Nestler, Steffen Ihlenfeldt

AMALGAMATION OF PHYSICS-BASED CUTTING FORCE MODEL AND MACHINE
LEARNING APPROACH FOR END MILLING OPERATION 1405
Ankit Agarwal, K. A. Desai

TOOL AND WORKPIECE DEFLECTION INDUCED FLATNESS ERRORS IN MILLING OF
THIN-WALLED COMPONENTS 1411
Ankit Agarwal, K. A. Desai

IN-PROCESS COMPENSATION OF STRAIGHTNESS DEVIATION IN BTA DEEP HOLE
DRILLING USING EXPERIMENTAL AND SIMULATIVE ANALYSIS 1417
J. F. Gerken, N. Klages, D. Biermann, B. Denkena

MILLING STABILITY IDENTIFICATION USING BAYESIAN MACHINE LEARNING 1423
Jaydeep Karandikar, Andrew Honeycutt, Scott Smith, Tony Schmitz

DEVELOPMENT OF A NEURAL NETWORK TO RECOGNIZE STANDARDS AND
FEATURES FROM 3D CAD MODELS 1429
Alexander Neb, Iyed Briki, Raoul Schoenhof

MEASUREMENT SYSTEM BASED ON THE SEEBECK EFFECT FOR THE
DETERMINATION OF TEMPERATURE AND TOOL WEAR DURING TURNING OF
ALUMINUM ALLOYS 1435
Thomas Junge, Hendrik Liborius, Thomas Mehner, Andreas Nestler, Thomas Lampke

EFFICIENT DYNAMIC MACHINE TOOL SIMULATION WITH INCLUDED DAMPING AND LINEARIZED FRICTION EFFECTS	1442
<i>T. Semm, D. Spescha, N. Ceresa, M. F. Zaeh, K. Wegener</i>	
INTELLIGENT ANOMALY DETECTION OF MACHINE TOOLS BASED ON MEAN SHIFT CLUSTERING	1448
<i>Markus Netzer, Jonas Michelberger, Jürgen Fleischer</i>	
PROCESS MONITORING AND IMPULSE DETECTION IN FACE MILLING USING CAPACITIVE ACCELERATION SENSORS BASED ON MEMS	1454
<i>Benjamin Clauß, Christoph Robert Meinecke, Wolfgang Günther, Simon Akthari, Andreas Schubert</i>	
STEP-NC ENABLED MACHINE TOOL DIGITAL TWIN.....	1460
<i>Tsubasa Kubota, Reza Hamzeh, Xun Xu</i>	
PROCESS MONITORING WITH A CYBER-PHYSICAL CUTTING TOOL.....	1466
<i>H.-C. Möhring, K. Werkle, W. Maier</i>	
DATA-BASED PROCESS ANALYSIS IN MACHINING PRODUCTION: CASE STUDY FOR QUALITY DETERMINATION IN A DRILLING PROCESS	1472
<i>Amina Ziegenbein, Alexander Fertig, Joachim Metternich, Matthias Weigold</i>	
VALIDATION OF MACHINING OPERATIONS BY A VIRTUAL NUMERICAL CONTROLLER KERNEL BASED SIMULATION	1478
<i>Johannes Schmid, Alexander Schmid, Rudolf Pichler, Franz Haas</i>	
A USE CASE TO IMPLEMENT MACHINE LEARNING FOR LIFE TIME PREDICTION OF MANUFACTURING TOOLS	1484
<i>Robin Oberlé, Sebastian Schorr, Li Yi, Moritz Glatt, Jan C. Aurich</i>	
INVESTIGATIONS ON THE INFLUENCE OF THE CEMENTED CARBIDE GRADE ON THE SURFACE INTEGRITY WHEN END MILLING DA 718	1490
<i>T. Bergs, M. Hardt, D. Schraknepper</i>	
DISCRETIZATION APPROACHES TO MODEL ORTHOGONAL CUTTING WITH LAGRANGIAN, ARBITRARY LAGRANGIAN EULERIAN, PARTICLE FINITE ELEMENT METHOD AND SMOOTH PARTICLE HYDRODYNAMICS FORMULATIONS	1496
<i>Praveen Sridhar, Juan Manuel Rodríguez Prieto, Kristin M. De Payrebrune</i>	
TOOL CONDITION PROGNOSTIC MODEL BASED ON DIGITAL TWIN SYSTEM	1502
<i>Nan Xie, Rui Kou, Yingzhe Yao</i>	
OPTIMIZING INDEX POSITIONS ON CNC TOOL MAGAZINES CONSIDERING CUTTING TOOL LIFE AND DUPLICATES	1508
<i>Kaveh Amouzgar, Amos H. C. Ng, Goran Ljustina</i>	
MODELING OF THE FRACTURE BEHAVIOR OF CBN GRAINS DURING SINGLE GRAIN DRESSING USING FEM.....	1514
<i>T. Bergs, M. Ohlert, S. Prinz, S. Barth</i>	
GRINDING WHEEL WEAR AND MATERIAL REMOVAL MECHANISMS DURING GRINDING OF POLYCRYSTALLINE DIAMOND	1520
<i>T. Bergs, U. Müller, F. Vits, S. Barth</i>	
"STRESS-ORIENTED, DATA-BASED PAYMENT MODEL FOR MACHINE TOOLS".....	1526
<i>Patrick Stanula, Christopher Praetzas, Oliver Kohn, Joachim Metternich, Arne Buchwald</i>	

DIGITAL TWIN APPROACH FOR TOOL WEAR MONITORING OF MICRO-MILLING..... 1532
Christiand, Gandjar Kiswanto

CUTTING FORCE AND STABILITY FOR INSERTED CUTTERS USING STRUCTURED
LIGHT METROLOGY 1538
No Timothy, Michael Gomez, Scott Smith, Tony Schmitz

USER-CENTERED INFORMATION PROVISION OF CYBER-PHYSICAL MACHINE TOOLS 1546
Zexuan Zhu, Xun Xu

MANUFACTURING SYSTEMS

APPROACH FOR AN ADAPTIVE CONTROL LOOP BETWEEN SUPPLY NETWORK AND
MANUFACTURING 1552
Dennis Bauer, Thomas Bauernhansl, Alexander Sauer

SENSING, PROCESS MONITORING AND CONTROL

VISUAL INSPECTION SYSTEM FOR ANOMALY DETECTION ON KTL COATINGS USING
VARIATIONAL AUTOENCODERS 1558
Nejc Kozamernik, Drago Bracun

Author Index