

25th CIRP Life Cycle Engineering Conference 2018

Procedia CIRP Volume 69

Copenhagen, Denmark
30 April - 2 May 2018

Part 1 of 2

Editors:

**Mikolaj Owsianiak
Morten Ryberg
Alexis Laurent
Monia Niero
Stig I. Olsen**

**Niki Bey
Michael Z. Hauschild
Alexandra Leclerc
Yan Dong**

ISBN: 978-1-5108-6192-3

Printed from e-media with permission by:

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



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

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

Printed by Curran Associates, Inc. (2018)

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

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

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

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

Additional copies of this publication are available from:

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

TABLE OF CONTENTS

PART 1

Advancing Life Cycle Engineering to meet United Nation's Sustainable Development Goals	1
<i>Michael Z. Hauschild, Alexis Laurent, Christine Molin</i>	
Target-driven Life Cycle Engineering: Staying within the Planetary Boundaries	3
<i>Sami Kara, Michael Z. Hauschild, Christoph Herrmann</i>	
A Critique of Life Cycle Assessment; Where Are the People?	11
<i>Timothy G. Gutowski</i>	
Show me the Money – Societal LCC or Optimizing for Societal and Business Value in Core Business Transactions	16
<i>Yann Risz, Craig Cammarata, Christopher Wellise, Matthew Swibel</i>	
The UN Sustainable Development Goals (SDGs) are a Great Gift to Business!	21
<i>Claus Stig Pedersen</i>	
Product Life Cycle Design for Sustainable Value Creation: Methods of Sustainable Product Development in the Context of High Value Engineering	25
<i>Jing Tao, Suiran Yu</i>	
A Methodical Approach for an Economic Assessment of Joining Technologies under Risk – Optimized Decision-making in Automobile Body Development	31
<i>Saphir A. Choudry, Steffen Sandmann, Dirk Landgrebe</i>	
Life Cycle Engineering Based on Visual Analytics	37
<i>Alexander Kaluza, Sebastian Gellrich, Felipe Cerdas, Sebastian Thiede, Christoph Herrmann</i>	
Life Cycle Engineering of Carbon Fibres for Lightweight Structures	43
<i>Antal Dér, Alexander Kaluza, Denis Kurlé, Christoph Herrmann, Sami Kara, Russell Varley</i>	
Life Cycle Engineering from the Perspective of an Engineering Consultancy	49
<i>Christine Collin, Andreas Linnet, Andreas Q. Secher</i>	
Construction Product Declarations and Sustainable Development Goals for Small and Medium Construction Enterprises	54
<i>Andreas Q. Secher, Christine Collin, Andreas Linnet</i>	
Sustainable Development Goals as a Guideline for Indicator Selection in Life Cycle Sustainability Assessment	59
<i>Christina Wulf, Jasmin Werker, Petra Zapp, Andrea Schreiber, Holger Schlor, Wilhelm Kuckshinrichs</i>	
Designing Future Visions of Sustainable Consumption and Production in Southeast Asia	66
<i>Yusuke Kishita, Shogo Kuroyama, Mitsutaka Matsumoto, Michikazu Kojima, Yasushi Umeda</i>	
Urban Factories and Their Potential Contribution to the Sustainable Development of Cities	72
<i>Max Juraschek, Michael Bucherer, Fabian Schnabel, Holger Hoffschröder, Benjamin Vossen, Felix Kreuz, Sebastien Thiede, Christoph Herrmann</i>	
A Proposal to Integrate System Dynamics and Carbon Metabolism for Urban Planning	78
<i>Thomas Elliot, Benedetto Rugani, Javier Babí Almenar, Samuel Niza</i>	
The Assessment of Urban Environmental Impacts through the City Environmental Footprint: Methodological Framework and First Approach to the Built Environment	83
<i>Nadia Mirabella, Karen Allacker</i>	
A Methodology Concept for Territorial Metabolism – Life Cycle Assessment: Challenges and Opportunities in Scaling from Urban to Territorial Assessment	89
<i>Joshua Sohn, Giovanna Croxatto Vega, Morten Birkved</i>	
Life Cycle Oriented Industrial Value Creation in Cities	94
<i>Max Juraschek, Eva Johanna Becht, Lennart Büth, Sebastian Thiede, Sami Kara, Christoph Herrmann</i>	
Integration of Waste Supply and Use Data into Regional Footprints: Case Study on the Generation and Use of Waste from Consumption and Production Activities in Brussels	100
<i>Vanessa Zeller, Edgar Towa, Marc Degrez, Wouter M. J. Achten</i>	
Dual-objective Analysis for Desktop FDM Printers: Energy Consumption and Surface Roughness	106
<i>Tao Peng, Fei Yan</i>	
Impact of Total Build Height and Batch Size on Environmental Performance of Electron Beam Melting	112
<i>Van Thao Le, Henri Paris</i>	
Framework to Combine Technical, Economic and Environmental Points of View of Additive Manufacturing Processes	118
<i>Mazyar Yosofi, Olivier Kerbrat, Pascal Mognol</i>	
The Role of Re-design for Additive Manufacturing on the Process Environmental Performance	124
<i>Paolo C. Priarone, Giuseppe Ingarao, Vincenzo Lunetto, Rosa Di Lorenzo, Luca Settineri</i>	
Energy and Cost Assessment of 3D Printed Mobile Case Covers	130
<i>Paolo Minetola, Daniel Eyers</i>	
A Sustainability Assessment Framework for Dynamic Cloud-based Distributed Manufacturing	136
<i>Hari P. N. Nagarajan, Arvind Shankar Raman, Karl R. Haapala</i>	
A Technical Assessment of Product/Component Re-manufacturability for Additive Remanufacturing	142
<i>Yahya Lahrou, Daniel Brissaud</i>	
Environmental Performance and Key Characteristics in Additive Manufacturing: A Literature Review	148
<i>Yahya Al-Meslehi, Nabil Anwer, Luc Mathieu</i>	
Life Cycle Assessment Applied to Circular Designed Construction Materials	154
<i>Sara Zanni, Isabela Maria Simion, Mariana Gavrilescu, Alessandra Bonoli</i>	

Life Cycle Assessment of a French Single-Family House Refurbishment: The “Bat-Eco2” Case Study	160
<i>Carolina Colli, Alain Bataille, Emmanuel Antezak, François Buyle-Bodina</i>	
Environmental Performance of Advanced Window Systems in Patient Rooms	166
<i>Nazanin Eisazadeh, Karen Allacker</i>	
Lessons Learned from Life Cycle Assessment and Life Cycle Costing of Two Residential Towers at the University of British Columbia	172
<i>Zahra Teshnizi, Angelique Pilon, Stefan Storey, Diana Lopez, Thomas M. Froese</i>	
Overview of Whole Building Life-Cycle Assessment for Green Building Certification and Ecodesign through Industry Surveys and Interviews	178
<i>Tytti Bruce-Hyrkäs, Panu Pasanen, Rodrigo Castro</i>	
Sustainability Tool to Optimise Material Quantities of Steel in the Construction Industry	184
<i>Bernardino D'Amico, Francesco Pomponi</i>	
Carbon Mitigation in the Built Environment: An Input-output Analysis of Building Materials and Components in the UK	189
<i>Francesco Pomponi, Bernardino D'Amico</i>	
A Comparative Life Cycle Assessment of Hot Mixes Asphalt Containing Bituminous Binder Modified with Waste and Virgin Polymers	194
<i>Joao Santos, Veronique Cerezo, Khedoudja Soudani, Sara Bressi</i>	
Visualizing Interdependencies Among Sustainability Criteria to Support Multicriteria Decision-making Processes in Building Design	200
<i>Marco Scherz, Bernd Markus Zunk, Alexander Passer, Helmuth Kreiner</i>	
Life Cycle Assessment of Innovative Materials for Thermal Energy Storage in Buildings	206
<i>Rafael Horn, Matthias Burr, Dominik Fröhlich, Stefan Gschwander, Michael Held, Jan Paul Lindner, Gunther Munz, Bjorn Nienborg, Peter Schossig</i>	
A Preliminary Systematic Investigation onto Sprayed Concrete's Environmental Performance	212
<i>Marcella Ruschi Mendes Saade, Alexander Passer, Florian Mittermayr</i>	
LCA and BIM: Integrated Assessment and Visualization of Building Elements' Embodied Impacts for Design Guidance in Early Stages	218
<i>Martin Röck, Alexander Hollberg, Guillaume Habert, Alexander Passer</i>	
Data Driven Quantification of the Temporal Scope of Building LCAs	224
<i>Natasha Østergaard, Laura Thorsted, Simona Miraglia, Morten Birkved, Freja Nygaard Rasmussen, Harpa Birgisdottir, Pradip Kalbar, Stylianos Georgiadis</i>	
A Pathway towards Sustainable Manufacturing for Mid-size Manufacturers	230
<i>Jun-Ki Choi, Ryan Schuessler, Michael Ising, Daniel Kelley, Kelly Kissock</i>	
Increasing Resource Efficiency of Manufacturing Systems Using a Knowledge-Based System	236
<i>Stefan Blume, Christoph Herrmann, Sebastian Thiede</i>	
A Methodology to Align Core Manufacturing Capabilities with Sustainable Manufacturing Strategies	242
<i>I. Barletta, C. Berlin, M. Despeisse, E. Van Voorthuysen, B. Johansson</i>	
Sustainability Assessment Framework for Manufacturing Sector – A Conceptual Model	248
<i>Vikrant Bhakar, A. K. Digalwar, Kuldip Singh Sangwan</i>	
Integrating Sustainability in the Development and Operation of High-volume Production Lines	254
<i>P. M. Stotz, N. Bey</i>	
Understanding Energy Consumption in a Machine Tool through Energy Mapping	259
<i>M. J. Triebe, G. P. Mendis, F. Zhao, J. W. Sutherland</i>	
Porous Metal Bonds Increase the Resource Efficiency for Profile Grinding	265
<i>Berend Denkena, Thilo Grove, Vino Suntharakumaran</i>	
Energy Load Profile Analysis on Machine Level	271
<i>Hanno Teiwes, Stefan Blume, Christoph Herrmann, Markus Rössinger, Sebastian Thiede</i>	
Environmental Impacts of Cooling Tower Operations – The Influence of Regional Conditions on Energy and Water Demands	277
<i>C. Schulze, B. Raabe, C. Herrmann, S. Thiede</i>	
New Plant-Technologies for Reducing Carbon Emissions and Costs in Heat Treatment Processes of Aluminium Castings	283
<i>Stefan Scharf, Norbert Dischinger, Baris Ates, Ulrich Schlegel, Norbert Stein, Hagen Stein</i>	
Energy Flow Analysis of an Alternative Fuel Production Facility in South Australia	288
<i>Seung Jin Kim, Ashley Thornton, Sami Kara</i>	
Development of a Structured Algorithm to Identify the Status of a Machine Tool to Improve Energy and Time Efficiencies	294
<i>Nitesh Sihag, Kuldip Singh Sangwan, Siddhant Pundir</i>	
Development of a Multi-criteria Optimization Model for Minimizing Carbon Emissions and Processing Time During Machining	300
<i>Nitesh Sihag, Kuldip Singh Sangwan</i>	
Decision Support for Planning Techniques in Energy Efficiency Projects	306
<i>Marian Süße, Johannes Stoldt, Andreas Schlegel, Matthias Putz</i>	
Optimization Parameters for Energy Efficiency in End Milling	312
<i>Lirong Zhou, Jianfeng Li, Fangyi Li, Gamini Mendis, John W. Sutherland</i>	
MAESTRI Efficiency Framework: The Concept Supporting the Total Efficiency Index. Application Case Study in the Metalworking Sector	318
<i>A. J. Baptista, E. J. Lourenço, E. J. Silva, M. A. Estrela, P. Peças</i>	

Peak Power Load and Energy Costs Using the Example of the Startup and Idling of a Grinding Machine	324
<i>Henning Voet, Ian C. Garretson, Björn Falk, Robert H. Schmitt, Barbara S. Linke</i>	
Data-driven Approach for Discovery of Energy Saving Potentials in Manufacturing Factory	330
<i>Bin Song, Yintai Ao, Li Xiang, K. Y. Ng Lionel</i>	
Applying Energy Building Simulation in the Assessment of Energy Efficiency Measures in Factories	336
<i>Max Weeber, EneDir Ghisi, Alexander Sauer</i>	
Analysis of Process Parameters Affecting Energy Consumption in Plastic Injection Moulding	342
<i>Isaac Meekers, Paul Refalo, Arif Rochman</i>	
Tooling for Production of the Green Fiber Bottle	348
<i>Prateek Saxena, Giuliano Bissacco, Filip J. Bedka, Alessandro Stolfi</i>	
Model-based Planning of Energy Flexible Technical Building Services in Production Plants to Integrate Variable Renewable Energies	354
<i>Dominik Flum, Eberhard Abele, Oliver Reidel</i>	
Decentral Control Strategies for Demand-side Management by Industrial Heating and Cooling Devices with Discontinuous Operation Mode	360
<i>Nina Strobel, Eberhard Abele</i>	
Simulative Analysis of a Flexible, Robust and Sustainable Energy Supply through Industrial Smart-DC-Grid with Distributed Grid Management	366
<i>Darian Andreas Schaab, Sebastian Weckmann, Timm Kuhlmann, Alexander Sauer</i>	
Sizing a Hybrid Renewable Energy System to Reduce Energy Costs at Various Levels of Robustness for an Industrial Site	371
<i>Ashley Thornton, Seung-Jin Kim, Sami Kara</i>	
Agent Based Simulation Model of Virtual Power Plants for Greener Manufacturing	377
<i>Stefan Woltmann, Maximilian Zarte, Julia Kittel, Agnes Pechmann</i>	
Affordable Process for the Production of Strontium Bromide Used in Low Grade Heat Recovery Applications	383
<i>David Gilles, Tiriana Segato, Emilie Courbon, Marc Degrez, Pierre D'Ans</i>	
Taking Evolution into Account in a Parametric LCA Model for PV Panels	389
<i>Ellen Bracquene, Jef R. Peeters, Wim Dewulf, Joost R. Duflou</i>	
Sustainability Assessment of Concentrated Solar Power (CSP) Tower Plants – Integrating LCA, LCC and LCWE in One Framework	395
<i>Nathanael Ko, Manuel Lorenz, Rafael Horn, Hannes Krieg, Michael Baumann</i>	
Case Analysis of Photovoltaic System Shared by a Small Enterprise and a Household	401
<i>Maximilian Zarte, Agnes Pechmann</i>	
Comparative Analysis for Solar Energy Based Learning Factory: Case Study for TU Braunschweig and BITS Pilani	407
<i>Kuldip Singh Sangwan, Christoph Herrmann, Manoj S. Soni, Sanjeev Jakhar, Gerrit Posselt, Nitesh Sihag, Vikrant Bhakar</i>	
A Taxonomy for Technology Models Used in Environmental Impact Studies	412
<i>Christopher L. Magee</i>	
Relating the Global Burden of Disease to Life Cycles	417
<i>Bo P. Weidema, Peter Fantke</i>	
A Meta-model based Approach for LCA-oriented Product Data Management	423
<i>Jing Tao, Suiran Yu</i>	
Organizational Life Cycle Assessment: The Introduction of the Production Allocation Burden	429
<i>Alessandro Manzardo, Andrea Loss, Monia Niero, Chiara Vianello, Antonio Scipioni</i>	
Spatially Differentiated Sustainability Assessment for the Design of Global Supply Chains	435
<i>Christian Thies, Karsten Kieckhäfer, Thomas S. Spengler, Manbir S. Sodhi</i>	
Structuring Complex Results using Network Maps and Hierarchical Charts	441
<i>Chloe A. Lanfers, Peter Fantke</i>	
Advancements in Unit Process Life Cycle Inventories (UPLCI) Tools	447
<i>M. Overcash, E. Griffing, E. Vozzola, J. Twomey, W. Flanagan, J. Isaacs</i>	
Prospective Assessment of Steel Manufacturing Relative to Planetary Boundaries: Calling for Life Cycle Solution	451
<i>Morten W. Ryberg, Peng Wang, Sami Kara, Michael Z. Hauschild</i>	
Exploring Deep Uncertainty Approaches for Application in Life Cycle Engineering	457
<i>Miroslava Tegeltija, Josef Oehmen, Igor Kozin, Jan Kwakkel</i>	
Ex-ante LCA of Emerging Technologies	463
<i>Stefano Cucurachi, Coen Van Der Giesen, Jeroen Guinée</i>	
Estimating Chemical Footprint on High-resolution Geospatial Grid	469
<i>Anna Makarova, Pavel Shlyakhov, Natalia Tarasova</i>	
Measuring Carbon Footprint of an Indian University Using Life Cycle Assessment	475
<i>Kuldip Singh Sangwan, Vikrant Bhakar, Vinti Arora, Prem Solanki</i>	
Life Cycle Assessment of the Production of Rare Earth Oxides from a Brazilian Ore	481
<i>Francisco Mariano Lima, Giancarlo Alfonso Lovon-Canchumani, Michel Sampaio, Ligia Marcela Tarazona-Alvarado</i>	
A Comprehensive Life-Cycle Assessment of Locally Oriented Small-Scale Toy Industries: A Study of traditional Channapatna Toys as Against Low-cost PVC (Poly-Vinyl Chloride) Toys Made in China	487
<i>Jananee Rangaswamy, Tarun Kumar, Kriti Bhalla</i>	
An Integrated Rural Development Model based on Comprehensive Life-Cycle Assessment (LCA) of Khadi-Handloom Industry in Rural India	493
<i>Kriti Bhalla, Tarun Kumar, Jananee Rangaswamy</i>	

PART 2

Life Cycle Assessment of Home Smart Objects: Kitchen Hood Cases	499
<i>Vincenzo Castorani, Marta Rossi, Michele Germani, Marco Mandolini, Alessio Vita</i>	
Considering Battery Degradation in Life Cycle Greenhouse Gas Emission Analysis of Electric Vehicles	505
<i>Fan Yang, Yuanyuan Xie, Yelin Deng, Chris Yuan</i>	
Life Cycle Assessment of a Hybrid Train – Comparison of Different Propulsion Systems	511
<i>Lilly Meynerts, José Brito, Inês Ribeiro, Paulo Peças, Soren Clause, Uwe Götze</i>	
Use of Liquefied Biomethane (LBM) as a Vehicle Fuel for Road Freight Transportation: A Case Study Evaluating Environmental Performance of Using LBM for Operation of Tractor Trailers	517
<i>Kavitha. Shanmugam, Mats. Tysklind, Venkata K. K. Upadhyayula</i>	
Life Cycle Model and Metrics in Shipbuilding: How to Use them in the Preliminary Design Phases	523
<i>Claudio Favi, Michele Germani, Federico Campi, Marco Mandolini, Steve Manieri, Marco Marconi, Alessio Vita</i>	
Life Cycle Assessment of Hydrogen Production and Consumption in an Isolated Territory	529
<i>Guangling Zhao, Allan Schrøder Pedersen</i>	
Parameters Affecting the Sustainability Trade-off between Production and Use Stages in the Automotive Lightweight Design	534
<i>M. Delogu, L. Zanchi, C. A. Dattilo, M. Ierides</i>	
Environmental Impacts of Urban Hydroponics in Europe: A Case Study in Lyon	540
<i>Daina Romeo, Eldbjørg Blikra Ve, Marianne Thomsen</i>	
Eco-designing Aquaponics: A Case Study of an Experimental Production System in Belgium	546
<i>Andrea Alberto Forchino, Vincent Gennotte, Silvia Maiolo, Daniele Brigolin, Charles Melard, Roberto Pastres</i>	
Combined Fish and Lettuce Cultivation: An Aquaponics Life Cycle Assessment	551
<i>Abigail Cohen, Stephen Malone, Zack Morris, Marc Weissburg, Bert Bras</i>	
LCA Towards Sustainable Agriculture: The Case Study of Cupuaçu Jam from Agroforestry	557
<i>F. Recanatì, A. Arrigoni, G. Scaccabarozzi, D. Marveggio, P. Melia, G. Dotelli</i>	
Industrial Symbiosis for Greener Horticulture Practices: The CO₂ Enrichment from Energy Intensive Industrial Processes	562
<i>B. Marchi, S. Zanoni, M. Pasetti</i>	
Comparative Study Using Life Cycle Approach for the Biodiesel Production from Microalgae Grown in Wastewater and Fresh Water	568
<i>Smita Raghuvanshi, Vikrant Bhakar, Ramakrishna Chava, K. S. Sangwan</i>	
Bio-based Plastics - A Building Block for the Circular Economy?	573
<i>Sebastian Spierling, Carolin Röttger, Venkateshwaran Venkatachalam, Marina Mudersbach, Christoph Hermann, Hans-Josef Endres</i>	
LCA and Eco-design: Consequential and Attributional Approaches for Bio-based Plastics	579
<i>Venkateshwaran Venkatachalam, Sebastian Spierling, Rafael Horn, Hans-Josef Endres</i>	
Life-Cycle Assessment and Life-Cycle Cost Study of Banana (Musa sapientum) Fiber Biocomposite Materials	585
<i>L. Joana Rodríguez, Carlos E. Orrego, Inês Ribeiro, Paulo Peças</i>	
Biowaste Valorisation in a Future Circular Bioeconomy	591
<i>Eldbjørg Blikra Ve, Daina Romeo, Marianne Thomsen</i>	
Facing the Information Leaks in Industrial Water Systems: A Concept for Proxy Measurements to Support Water Metering Audits	597
<i>Dominik Seiler, Dan Donovan, Garret E. O'Donnell</i>	
Life Cycle Assessment of Groundwater Supply System in a Hyper-arid Region of India	603
<i>Prashant Bhakar, Ajit Pratap Singh</i>	
Integrated Greywater Management Systems: A Design Proposal for Efficient and Decentralised Greywater Sewage Treatment	609
<i>Shanthanu S. Ashok, Tarun Kumar, Kriti Bhalla</i>	
Life Cycle Tradeoffs in a Feedback Device for Reducing Water Consumption	615
<i>Cassandra Telenko, Nicholas Benzoni</i>	
Teaching Sustainability Leadership in Manufacturing: A Reflection on the Educational Benefits of the Board Game Factory Heroes	621
<i>Mélanie Despeisse</i>	
Sustainability and LCA in Engineering Education – A Course Curriculum	627
<i>Stig I. Olsen, Peter Fantke, Alexis Laurent, Morten Birkved, Niki Bey, Michael Z. Hauschild</i>	
Challenges in Coupling Digital Payments Data and Input-output Data to Change Consumption Patterns	633
<i>Massimo Pizzol, Elena Vighi, Romain Sacchi</i>	
Exploring the Potentials of Mixed Reality for Life Cycle Engineering	638
<i>Max Juraschek, Lennart Büth, Felipe Cerdas, Alexander Kaluza, Sebastian Thiede, Christoph Herrmann</i>	
Environmental Sustainability of Cyber Physical Production Systems	644
<i>Sebastian Thiede</i>	
An IoT Based Approach for Energy Flexible Control of Production Systems	650
<i>Julia Schulz, Richard S.-H. Popp, Valerie M. Scharmer, Michael F. Zaeh</i>	
An IoT-enabled Approach for Energy Monitoring and Analysis of Die Casting Machines	656
<i>Weipeng Liu, Renzhong Tang, Tao Peng</i>	
IoT-enabled Dynamic Optimisation for Sustainable Reverse Logistics	662
<i>Sichao Liu, Geng Zhang, Lihui Wang</i>	
Virtual Eco-design: How to Use Virtual Prototyping to Develop Energy-labelling Compliant Products	668
<i>Anna Costanza Russo, Marta Rossi, Daniele Landi, Michele Germani, Claudio Favi</i>	

Energy Label Directive: Current Limitations and Guidelines for the Improvement	674
<i>Anna Costanza Russo, Marta Rossi, Michele Germani, Claudio Favi</i>	
Supporting Product Development with a Practical Tool for Applying the Strategy of Resource Circulation	680
<i>M. E. Toxopeus, N. B. Van Den Hout, B. G. D. Van Diepen</i>	
Development of Industry-focused, Life Cycle Assessment Enhanced Eco-Design Software	686
<i>D. Wehner, X. Chen, L. Petruccelli, K. Marshall, A. Clifton, S. Schulz</i>	
Towards Operable Criteria of Eco-innovation and Eco-ideation Tools for the Early Design Phases	692
<i>O. Pialot, D. Millet</i>	
A Life Cycle Ecological Sensitivity Analysis Method for Eco-Design Decision Making of Machine Tool	698
<i>Dan Zeng, Huajun Cao, Salman Jafar, Yifei Tan, Shu Su</i>	
A Framework for Determining the Life Time Energy Consumption of a Product at the Concept Design Stage	704
<i>S. M. Ibbotson, S. Kara</i>	
Product Recoverability: A Review of Assessment Methods	710
<i>J. Martínez Leal, S. Pompidou, C. Charbuillet, N. Perry</i>	
Ecodesign of Personal Computers: An Analysis of the Potentials of Material Efficiency Options	716
<i>Paolo Tecchio, Fulvio Ardente, Max Marwede, Christian Clemm, Gergana Dimitrova, Fabrice Mathieux</i>	
Lean Design-for-X Methodology: Integrating Modular Design, Structural Optimization and Ecodesign in a Machine Tool Case Study	722
<i>A. J. Baptista, D. Peixoto, A. D. Ferreira, J. P. Pereira</i>	
Function-driven Investigation of Non-renewable Energy Use and Greenhouse Gas Emissions for Material Selection in Food Packaging Applications: Case Study of Yoghurt Packaging	728
<i>Ankit Aggarwal, Markus Schmid, Martin Kumar Patel, Horst-Christian Langowski</i>	
Systematization of Virtual Product Twin Models in the Context of Smart Product Reconfiguration during the Product Use Phase	734
<i>Michael Abramović, Philipp Savarino, Jens Christian Göbel, Stefan Adwernat, Philip Gebus</i>	
Toward Developing a Design Method of Personalization: Proposal of a Personalization Procedure	740
<i>Kazuki Kaneko, Yusuke Kishita, Yasushi Umeda</i>	
A Framework of Energy Services: From Traditional Contracts to Product-Service System (PSS)	746
<i>D. Mourtzis, N. Boli, K. Alexopoulos, D. Rózycki</i>	
Exploring Circular Strategy Combinations - Towards Understanding the Role of PSS	752
<i>Fenna Blomsma, Louise Kjaer, Daniela Pigosso, Tim McAloone, Stafford Lloyd</i>	
Literature Reviews: Life Cycle Assessment in the Context of Product-Service Systems and the Textile Industry	758
<i>Felix M. Piontek, Martin Müller</i>	
Life Cycle Gaps: Interpreting LCA Results with a Circular Economy Mindset	764
<i>Michael Dieterle, Philipp Schäfer, Tobias Viere</i>	
IMPACT: A Tool for R&D Management of Circular Economy Innovations	769
<i>Jacco Verstraeten-Jochensen, Elisabeth Keijzer, Toon Van Harmelen, Lucinda Kootstra, Peter Kuindersma, René Koch</i>	
Circular Economy Through Objectives – Development of a Proceeding to Understand and Shape a Circular Economy Using Value-focused Thinking	775
<i>Christoph J. Velte, Katharina Scheller, Rolf Steinhilper</i>	
Development of an Evaluation Tool for Engineering Sustainable Recycling Pathways	781
<i>Guilhem Grimaud, Nicolas Perry, Bertrand Laratte</i>	
Approach to Enable a Material Efficiency-Strategy for Small and Medium Sized Manufacturing Enterprises	787
<i>Peter Kleine-Moellhoff, Anja T. Braun, Volker Reichenberger, Stephan Seiter</i>	
The Role of Life Cycle Sustainability Assessment in the Implementation of Circular Economy Principles in Organizations	793
<i>Monia Niero, Ximena C. Schmidt Rivera</i>	
Sustainable Qualifying Criteria for Designing Circular Business Models	799
<i>Marina De Pádua Pieroni, Daniela C. A. Pigosso, Tim C. McAloone</i>	
Using Values Management for Shifting Companies to Circular Economy	805
<i>Tomasz Stec, Peggy Zwolinski</i>	
Exploring the Implementation of a Circular Economy Strategy: The Case of a Closed-loop Supply of Aluminum Beverage Cans	810
<i>Raphaëlle Stewart, Monia Niero, Karen Murdock, Stig I. Olsen</i>	
A Methodological Approach to Development of Circular Economy Options in Businesses	816
<i>Michael Søgaard Jørgensen, Arne Remmen</i>	
Modelling and Assessment of Product Recovery Strategies through Systems Dynamics	822
<i>Yohannes A. Alamerew, Daniel Brissaud</i>	
Intermediate Bulk Containers Re-use in the Circular Economy: An LCA Evaluation	827
<i>Laura Biganzoli, Lucia Rigamonti, Mario Grosso</i>	
A Study of Formal Post-products Collected to Reuse Business Structures on Resource Sustainability through System Dynamics	833
<i>Juntao Wang, Wenhua Li, Nozomu Mishima</i>	
Lifecycle Simulation Method for System of Systems Focusing on Interaction Modeling	838
<i>Hidenori Murata, Hideki Kobayashi, Shinichi Fukushima</i>	
The Impact of Joining Choices on Vehicle Recycling Systems	843
<i>Vi Kie Soo, Paul Compston, Matthew Doolan</i>	

A Collaboration Platform for Enabling Industrial Symbiosis: Application of the Database Engine for Waste-to-Resource Matching	849
<i>Jonathan Sze Choong Low, Tobias Bestari Tjandra, Fajrian Yunus, Si Ying Chung, Daren Zong Loong Tan, Benjamin Raabe, Ng Yen Ting, Zhiquan Yeo, Stephane Bressan, Seeram Ramakrishna, Christoph Herrmann</i>	
Sustainability-based Optimization Criteria for Industrial Symbiosis: The Symbioptima Case	855
<i>C. Brondi, S. Cornago, A. Ballarino, A. Avai, D. Pietrarola, U. Dellepiane, M. Niero</i>	
Towards a Biologically-inspired Urban-industrial Ecosystem	861
<i>Zackery Morris, Marc Weissburg, Bert Bras</i>	
The Application of Detrital Actors in Industrial Systems	867
<i>Stephen M. Malone, Abigail R. Cohen, Bert Bras, Marc Weissburg</i>	
Industrial Symbiosis Implementation by Leveraging on Process Efficiency Methodologies	872
<i>M. Holgado, M. Benedetti, S. Evans, A. J. Baptista, E. J. Lourenço</i>	
An Approach to the Assessment of Durability of Energy-related Products	878
<i>Felice Alfieri, Mauro Cordella, Javier Sanfelix, Nicholas Dodd</i>	
Resource Efficient Regrinding of Cemented Carbide Milling Tools	882
<i>Berend Denkena, Thilo Grove, Mirko Theuer, Yanwei Liu</i>	
Development of an Approach for Assessing the Reparability and Upgradability of Energy-related Products	888
<i>Mauro Cordella, Javier Sanfelix, Felice Alfieri</i>	
Characterization of Machinability and Environmental Impact of Cryogenic Turning of Ti-6Al-4V	893
<i>A. Damir, A. Sadek, H. Attia</i>	
Maintenance Optimization: Application of Remanufacturing and Repair Strategies	899
<i>J. Wakiru, L. Pintelon, P. N. Muchiri, P. Chemweno</i>	
Identification of Critical Components Using ANP for Implementation of Reliability Centered Maintenance	905
<i>G. Gupta, R. P. Mishra</i>	
Consumer Perspectives on Longevity and Reliability: A National Study of Purchasing Factors Across Eighteen Product Categories	910
<i>Alex Gnanapragasam, Christine Cole, Jagdeep Singh, Tim Cooper</i>	
A Semi-automatic System for Efficient Recovery of Rare Earth Permanent Magnets from Hard Disk Drives	916
<i>Timothy R. Simon, Liang Cong, Yuxin Zhai, Yongxian Zhu, Fu Zhao</i>	
Integrated Workstation Design and Buffer Allocation in Disassembly Systems for Remanufacturing	921
<i>N. Shabanpour, M. Colledani</i>	
Forecasting Real Disassembly Time of Industrial Batteries Based on Virtual MTM-UAS Data	927
<i>Therese E. Schwarz, Wolfgang Rübenbauer, Bettina Rutrecht, Roland Pomberger</i>	
Backtracking Algorithm-based Disassembly Sequence Planning	932
<i>Bingbing Li, Li Ding, Di Hu, Shengzi Zheng</i>	
Managing Supply Chain Complexity: Foresight for Wind Turbine Composite Waste	938
<i>Al Amin Mohamed Sultan, Paul Tarisai Mativenga, Eric Lou</i>	
Reuse of Tires Textile Fibers in Plastic Compounds: Is this Scenario Environmentally Sustainable?	944
<i>Marco Marconi, Daniele Landi, Ivan Meo, Michele Germani</i>	
A Benchmark Study of Waste Tyre Recycling in South Africa to European Union Practice	950
<i>M. R. Sebola, P. T. Mativenga, J. Pretorius</i>	
Environmental Performance of Waste Management in an Italian Region: How LCI Modelling Framework Could Influence the Results	956
<i>M. Pini, P. Neri, A. M. Ferrari</i>	
Environmental Assessment of End-of-Life Textiles in Denmark	962
<i>Athina Koligkioni, Keshav Parajuly, Birgitte Liholt Sørensen, Ciprian Cimpan</i>	
End-of-life Management of Computers in Brussels: Environmental Comparison of Two Treatment Chains	968
<i>Louise Gonda, Marc Degrez</i>	
Waste Management of Discarded Cell Phones and Proposal of Material Recovery Techniques	974
<i>Edwin Wansi, Pierre D'Ans, Louise Gonda, Tiriana Segato, Marc Degrez</i>	
Enhancing Reuse and Resource Recovery of Electrical and Electronic Equipment with Reverse Logistics to Meet Carbon Reduction Targets	980
<i>Christine Cole, Alex Gnanapragasam, Jagdeep Singh, Tim Cooper</i>	
Optimized Collection of EoL Electronic Products for Circular Economy: A Techno-economic Assessment	986
<i>Elisavet Angouria-Tsorochidou, Ciprian Cimpan, Keshav Parajuly</i>	
Author Index	