Center for Advanced Manufacturing & Lean Systems
The University of Texas at San Antonio
San Antonio, Texas 78249
USA

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S M T Fatemi Ghomi, Amirkabir University of Technology, Iran
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Preface

The International Conference on Flexible Automation and Intelligent Manufacturing (FAIM) is a leading international forum to disseminate information of the most recent and relevant research, theories and practices on flexible automation, and manufacturing processes and systems. With the increasing emphasis on the pursuit of enterprise level of excellence, the chosen theme of FAIM2014 is "***Capturing Competitive Advantage via Advanced Manufacturing and Enterprise Transformation.***"

The 1st International FAIM conference in 1991 was resulted from collaboration between the
University in Limerick (UL) and the Virginia Polytechnic Institute. Prof. Munir Ahmad (then UL), and Prof. Bill Sullivan (then Virginia Tech.) have been central to the development and continuation of the Conference since its inception. The Conference has been held annually for the last 23 years. The list of previous FAIM conferences, by year and location, is as follows:

- 2013 University of Porto, Porto, Portugal
- 2012 Tampere University of Technology, Helsinki-Stockholm-Helsinki
- 2011 Feng Chia University, Taichung, Taiwan
- 2010 California State University, East Bay, Oakland, USA
- 2009 University of Teesside, Middlesbrough, UK
- 2008 University of Skövde, Sweden
- 2007 Penn State Great Valley, Philadelphia, USA
- 2006 University of Limerick, Limerick, Ireland
- 2005 University of Deusto, Bilbao, Spain
- 2004 Ryerson University, Toronto, Canada
- 2003 University of South Florida, Tampa, USA
- 2002 Dresden University of Technology, Dresden, Germany
- 2001 Dublin City University, Dublin, Ireland
- 2000 University of Maryland, Maryland, USA
- 1999 Tilburg University, Tilburg, Netherlands
- 1998 Portland State University, Portland, Oregon, USA
- 1997 University of Teesside, Middlesbrough, UK

- 1996 Georgia Institute of Technology, Atlanta, USA
- 1995 University of Stuttgart, Germany
- 1994 Virginia Tech, Blacksburg, Virginia, USA
- 1993 University of Limerick, Limerick, Ireland
- 1992 Virginia Tech (in Washington DC), USA
- 1991 University of Limerick, Limerick, Ireland

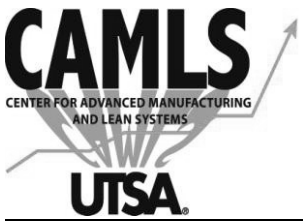
The above series of conferences have been successfully providing a forum for academicians, researchers, and practitioners to learn and exchange ideas. For the first two decades since its inception, the conference series have been alternately hosted between Europe and North America. In 2011, FAIM conference was held in Taiwan, the first time ever the conference was held outside of North America and Europe. A total of 261 abstracts were received for this year's conference and all full-length manuscripts have undergone the stringent peer-review process with at least two reviewers for each manuscript. 150 manuscripts were accepted or conditionally accepted. Revised final version of 142 papers (nearly 500 authors from 39 countries) has been finally accepted for presentation in the FAIM2014 conference program and publication in the FAIM2014 conference proceedings.

Acknowledgements

We wish to gratefully acknowledge Professor W. G. Sullivan and Professor M. M. Ahmad, the founders of FAIM international conferences, for their trust and guidance. Our great appreciation also goes to members of the International Scientific Committee and many other colleagues and friends for their prompt responses and work in the paper manuscript review process. The distinguished keynote speaker, special panel moderators and panelists who share their visions and valuable opinions also deserved our wholehearted thankfulness. We also wish to thank all authors who shared their scholarly research and many presenters travelled from different parts of the world to San Antonio, Texas to present their work.

Finally, we wish to acknowledge the support of College of Engineering, and Department of Mechanical Engineering, the University of Texas at San Antonio. The excellent support and facilitation provided by the leadership and staff of the Office of Extended Education at UTSA Downtown Campus made it possible for us to bring this prestigious international conference to center of the beautiful city of San Antonio. We are indebted to all faculty, staff and students of the Center for Advanced Manufacturing, whose contributions may go unnoticed.

F. Frank Chen, FAIM2014 Conference Chair &
FAIM2014 Program Committee



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Conference Program/ Schedule

Program Schedule				
Time & Date	**Tuesday, May 20, 2014**	**Wednesday, May 21,2014**	**Thursday, May 22, 2014**	**Friday, May 23, 2014**
7:30		Breakfast, Check-in and Registration 7:30-8:30		
8:00				
8:30		Welcome and Opening Ceremony 8:30-8:45 Keynote Speech 8:45-10:00	Panel Discussion 8:30-10:00	Panel Discussion 8:30-10:00
9:00	Pre-Conference Workshop & Plant Tour *9:00 -5:00*			
9:30				
10:00				
10:30		Break 10:00-10:30	Break 10:00-10:30	Break 10:00-10:30
11:00		Parallel Sessions (W1) 10:30-12:20	Parallel Sessions (T1) 10:30-12:20	Parallel Sessions (F1) 10:30-11:40
11:30				
11:40				
12:00				Closing Statements 11:40-12:00
12:20		Lunch 12:20-1:30	Lunch 12:20-1:30	Lunch 12:00 Toyota & SwRI Tours 12:30-4:00
13:00				
13:30				
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14:30				
15:00				
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15:30		Parallel Session (W3) 3:30-5:00	Parallel Session (T3) 3:30-5:00	
16:00				
16:30				
17:00				
17:30		Evening Social Hours/ Personal Free Hours at Riverwalk or other attractions		
18:00	Check-in and Registration 6:00 Evening Reception 6:00-9:00		Conference Banquet 6:00-9:30 Bus to leave at 6:00	
18:30				
19:00				
19:30				
20:00				
20:30				
21:00				

Notes: Snacks and refreshments served in all Break/Network periods.

Full-lunch served in both Wednesday and Thursday; Boxed lunch served on Friday.

Continental breakfast served in all three days.

Welcome & Opening Ceremony
(Wednesday, May 21, 2014 8:30-8:45)
FAIM Honorary Chairs and FAIM2014 Chair
Room: BV 1.328 (Aula Canaria Room)

Keynote Speaker and Panel Discussions:

Keynote Speech

(Wednesday May 21, 2014 8:45-10:00)

Speaker: Dr. Hsu-Pin (Ben) Wang, Georgia Tech

"Manufacturing 2.0: Challenges and Opportunities"
Room: BV 1.328 (Aula Canaria Room)

Panel Discussion 1 **(Thursday, May 22, 2014 8:30-10:00)**

Moderators:	**Prof. Don T. Phillips, Texas A&M University**
	Prof. J. T. Black, Auburn University
Speakers:	**Prof. F. Frank Chen, Univ. of Texas at San Antonio**
	Dr. Victoria Jordan, MD Anderson Cancer Center
Topic:	**"**Lean Engineering"
Room:	BV 1.328 (Aula Canaria Room)

Panel Discussion 2 **(Friday, May 23, 2014 8:30-10:00)**

Moderator:	**Prof. Can Saygin, Univ. of Texas at San Antonio**
Speakers:	**Mr. Paul Rad, Rackspace, Inc.**
	Paul Evans, Southwest Research Institute
	Dr. Shane Moeykens, ANSYS, Inc.
	Mr. Klaus Weiswurm, ITM
Topic:	**"**Cloud-based Manufacturing: *Perspectives from Industry and Academia"*
Room:	BV 1.328 (Aula Canaria Room)

Closing Statements **(Friday May 23, 2014 11:40-12:00)**
Room: BV 1.328 (Aula Canaria Room)

W11. Simulation, Modeling & Optimization (Wednesday May 21, 2014 10:30-12:20) Room: BV 1.312

Yifan Wu, Liping Liu, and Shuxia Li
"On a Paired-t Confidence Interval Based Ranking and Selection Method"

Emile Glorieux, Bo Svensson, Fredrik Danielsson, and Bengt Lennartson
"A Constructive Cooperative Coevolutionary Algorithm Applied to Press Line Optimisation"

Silvia Furtáková, Milan Gregor, and Jozef Hnát
"Simulation Metamodelling of Chosen Production System"

V. Kumar, A. Kumari, M. Brady, J.A. Garza-Reyes, A. Bhattacharya, and L. Rocha-Lona
"Resolving Waiting Time Issue in Healthcare: A Simulation Modelling Approach"

Adel Alaeddini
"Using Adaptive Neuro-Fuzzy Inference Systems to Monitor Non-Linear Quality Profiles"

W12. Inventory, Layout, Warehousing (Wednesday May 21, 2014 10:30-12:20) Room: BV 1.318

Sadia Quader and Krystel K. Castillo-Villar
"A Study of the Performance of Bucket Brigades when dealing with Multiple Aisles in Warehouses"

Ming Dong, Feng Zhu, and Dali Zhang
"User Phase Information Based Inventory Policy for Supply Chain Systems with Remanufacturing"

Krishan Rana and Esther Rodriguez-Silva
"Role of Port Management in Intercontinental Distribution"

Cun Rong Li, Bhaba R. Sarker, Hui Zhi Yi, and Meng Yu
"Procurement Policy of Vulnerable Parts with Jointly Distributed Lifespan"

Shu-Xia Li, Ti-Jun Fan, Lin Li, Chen-Hao Fang and Hao Yang
"Genetic Algorithm-based Insulation Box Line Layout Optimization for LNG Ship"

W13. Manufacturing Processes (I) (Wednesday May 21, 2014 10:30-12:20) Room: BV 3.324

Zhiqian Sang and Xun Xu
"Auto-recovery from Machining Stoppages based on STEP-NC"

Oscar Velásquez Arriaza, Dong-Won Kim, Jong-Yeong Lee and M.A. Suhaimi
"Balancing Tradeoffs between Machining Time and Energy Consumption for Impeller Rough Machining"

M.A. Suhaimi, Dong-Won Kim, and Besmir K. Cuka
"Roughing an Impeller: A Review"

M.A. Suhaimi, Dong-Won Kim, Jong-Yeong Lee, and Oscar Velasquez Arriaza
"Rough-Cut Machining an Impeller with 3-Axis and 5-Axis NC Machines"

Chong Peng, Lun Wang, and T. Warren Liao
"A Prototype Web Based Decision Support System for Cutting Parameters Selection based on Machining Features"

W14. Energy & Resource Efficiency (Wednesday May 21, 2014 10:30-12:20) Room: BV 3.326

Dennis Bakir, Horst Meier, and Björn Krückhans
"Economic and Ecologic Assessment within Small and Medium-sized Enterprises to increase Industrial Resource Efficiency"

Manuela Krones and Egon Müller
"Structuring Energy Efficiency Measures in Manufacturing Industry"

Enrico Oliva, Giovanni Berselli, and Marcello Pellicciari
"A Novel Engineering Method for the Power Flow Assessment in Servo-actuated Automated Machinery"

Yi-Chi Wang, Ming-Jun Wang, and Sung-Chi Lin
"Optimization of Cutting Parameters for Parallel Machine Scheduling with Constrained Power Demand Peak"

S. Aslan, B. Asiabanpour, H. Salamy, J. Jimenez, and R. Cook
"Constant Power Production and Harvesting Using Roof Ventilation Systems"

W15. Supply Chain Design & Model (Wednesday May 21, 2014 10:30-12:20) Room: BV 3.328

Krystel K. Castillo-Villar and José F. Herbert-Acero
"A Preliminary Study of the Impact of the Genotype Representation of a Genetic Algorithm on the Supply Chain Design Performance"

YiWen Chen, Li-Chih Wang, Tzu-Li Chen, Allen Wang, and Chen-Yeng Cheng
"A Multi-Objective Model for Solar Industry Closed-Loop Supply Chain by Using Particle Swarm Optimization"

Qinglin Duan and T. Warren Liao
"A New Stochastic Simulation Optimization Methodology for Supply Chain Inventory Optimization with Imperfect Quality Items"

Hui Zhi Yi, Bhaba R. Sarker, and Cun Rong Li
"Impact of Finite Life Cycle to a Consignment Stocking Supply Chain with Uncertain Demand"

Hernán Chávez, Krystel K. Castillo-Villar, Luis Herrera, and Agustín Bustos
"Simulation-based Optimization Model for Supply Chains with Disruptions in Transportation"

W21. Cloud/Web-Based Manufacturing (Wednesday May 21, 2014 1:30-3:00) Room: BV 1.312

Jan Schlechtendahl, Zhiqian Sang, Felix Kretschmer, Xun Xu, and Armin Lechler
"Study of Network Capability for Cloud Based Control Systems"

Göran Adamson, Lihui Wang, Magnus Holm, and Philip Moore
"Adaptive Robotic Control in Cloud Environments"

James Farris, Binbin Li, Tongdan Jin, and Heping Chen
"Design of a Cost-Effective Wireless System for Estimating Solar Photovoltaics Generation"

Xue-Wei Zhang, Tian-Biao Yu, Wan-Shan Wan, and Wei-Li Liang
"Modeling and Simulation of Web-based Virtual Turn-milling Center"

W22. MES, Supplier & Project Management (Wednesday May 21, 2014 1:30-3:00) Room: BV 1.318

Sangil Lee, Kwangyeol Ryu, Moonsoo Shin, and Hyunbo Cho
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Hwaseop Lee, Kwangyeol Ryu, Yongju Cho, and Hyunjei Jo
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Bingqing Wu, Bhaba R. Sarker, and Krishna Paudel
"Plant Location-allocation for Bio-methane Gas Production Systems"

O.O. Odimabo and C.F. Oduoza
"Methodology for Project Risk Assessment Using Bayesian Belief Networks in Engineering Construction Projects"

W23. Machine Tools & Control (Wednesday May 21, 2014 1:30-3:00) Room: BV 3.324

Joseph M. Flynn, Vimal Dhokia, and Stephen T. Newman
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Gyeong-Bok Lee, Cheol-Soo Lee, Eun-Young Heo, and Dong-Won Kim
"Predicting Material Properties of Flow Formed Work-piece Based on a Finite Deformation Method"

Kyung-tae Byun, Jong-min Kim, Eung-young Heo, and Cheol-soo Lee
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Xinyu Liu and Weihang Zhu
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W24. FMS, CNC & Automation (Wednesday May 21, 2014 1:30-3:00) Room: BV 3.326

Hoejin Kim and David E. Culler
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Matthias Keinert, Benjamin Kaiser, Armin Lechler, and Alexander Verl
"Analysis of CNC Software Modules regarding Parallelization Capability"

Ch. Woegerer, M. Rooker, A. Angerer, Ch. Kopf, and A.Pichler
"A Fast and Accurate Recognition System for Flexible Grasping of Electronic Goods"

Cheol-Soo Lee, Eun-Young Heo, Dong Yoon Lee, Jong-Min Kim, and Dong-Won Kim
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W25. Manufacturing Systems (I) (Wednesday May 21, 20141:30-3:00) Room: BV 3.328

Blake A. Kendrick, Vimal Dhokia, and Stephen T. Newman
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Trumone Sims and Hung-da Wan
"Applying Theory of Constraints to Moving Assembly Lines"

Erik Puik, Daniel Telgen, Leo van Moergestel, and Darek Ceglarek
"Classification of Reconfiguration Resources and Lead Time for Reconfigurable Manufacturing Systems"

Arsalan Shafiq, Aamer Baqai, and SajidUllah Butt
"Comparative Analysis between Small Displacement Torsor and Model of Indeterminate Applied On Generated Solution of Reconfigurable Manufacturing System"

W31.Product Development (I) (Wednesday May 21, 2014 3:30-5:00) Room: 1.312

Jihoon Kim, Kyoung-Yun Kim, Ohbyung Kwon
"Evaluation Framework for Crowdsourced Design Concept Management"

David E. Culler and Noah Anderson
"Creating a Flexible Data Management Environment in CAD/CAE/CAM for Product Lifecycle Management"

Uwe Dombrowski, David Ebentreich, and Stefan Schmidt
"Value Stream Mapping along the Product Development Process"

Narges Asadi, Joel Schedin, Anders Fundin, and Mats Jackson
"Considering assembly requirement specifications in product development: Identification and Approach"

W32. Production Planning & Scheduling (I) (Wednesday May 21, 2014 3:30-5:00) Room: BV 1.318

Po-Hsiang Lu, Hao Tan, Yong-Han Peng, Chen-Fu Chen, and Muh-Cherng Wu
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Lawrence Al-Fandi and Faisal Aqlan
"Using Simulation to Determine the Batch Size for I/O Drawer Test Process in a High-End Server Manufacturing Environment"

Henri Tokola, Esko Niemi, and Pekka Kyrenius
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Dipl.-Ing. Christoph Taphorn
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W33. Lean Manufacturing & Operations (I) (Wednesday May 21, 2014 3:30-5:00) Room: BV 3.324

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Osama Alaskari, M Munir Ahmad, and Ruben Pinedo-Cuenca
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Patrik Spalt, Anja-Tatjana Braun, Oliver Schöllhammer and Thomas Bauernhansl
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Adeolu A. Adeyemi, Jose Arturo Garza-Reyes, Ming K. Lim, Vikas Kumar, and Luis Rocha-Lona
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Redha M. Elhuni and M. Munir Ahmad
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Omar Espinoza, Urs Buehlmann, and Brian Bond
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W35. Safety, Ergonomics & HF (Wednesday May 21, 2014 3:30-5:00) Room: BV 3.328

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Jochen Bönig, Jerome Perret, Christian Fischer, Holger Weckend, Florian Döbereiner and Jörg Franke
"Creating Realistic Human Model Motion by Hybrid Motion Capturing Interfaced with the Digital Environment"

Qili Chen and Seng Fat Wong
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T11. Decision Support, Simulation & Modeling (Thursday May 22, 2014 10:30-12:20) Room: BV 1.312

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Krishnan Krishnaiyer and F. Frank Chen
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David Meinel, Paryanto and Jörg Franke
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Seung Yup Lee, Kyoung-Yun Kim, and Evrim Dalkiran
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T12. Enterprise Engineering& Management (Thursday May 22, 2014 10:30-12:20) Room: BV 1.318

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Liyu Zheng, Peter Sandborn, Janis Terpenny, and Nihal Orfi
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V. Potocan and Z. Nedelko
"How to Use the Management Tools in Enterprises: Initial Evidence about Use and Key Drivers of Management Tools among Employees"

Américo Azevedo, Filipe Ferreira, and José Faria
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Paul-Eric Dossou and Philip Mitchell
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T13. Manufacturing Processes (II) (Thursday May 22, 2014 10:30-12:20) Room: BV 3.324

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Jens Friedrich, Henning Hartmann, Alexander Verl, and Armin Lechler
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Barry Moore, Farhad Nabhani, Vahid Askari, Desmond McMenamim
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Paul A. Wilson, Richard E. Billo, John R. Durret, and John W. Priest
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Richard E Billo, Paul A. Wilson, John W. Priest, Mario Romero-Ortega, Shannon Brunskill, and David Keens
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Augusto Carreon, Chidentree Treesatayapun, and Arturo Baltazar
"Implementation of a Force Controller Based On Fuzzy Rule Emulate Networks for Soft Contact with an Object with Unknown Mechanical Properties"

William C. Flannigan, Paul T. Evans, Shaun M. Edwards, and Paul B. Hvass
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Gabriel Tamashiro, Kelen C. T. Vivaldini, José Martins Jr. and Marcelo Becker
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André Hurzig and Egon Müller
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Achim Kampker, Hanno Voet, Peter Burggräf, Moritz Krunke, and Kai Kreisköther
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Björn Krückhans, Horst Meier and Dennis Bakir
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Sobhi Mejjaouli and Radu F. Babiceanu
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Martina Winkelhoferova and Jiri Tupa
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Heshan Fernando and Brian Surgenor
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T23. Manufacturing Processes (III) (Thursday May 22, 2014 1:30-3:00) Room: BV 3.324

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T24. QC, 6 Sigma, & Operations Management (Thursday May 22, 2014 1:30-3:00) Room: BV 3.326

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Tzu-Liang (Bill) Tseng, Jun Zheng, Johnny C. Ho, Chun-Che Huang, Luis A. Ochoa, Yirong Lin and Richard Chiou
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Adel Alaeddini
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T25. Manufacturing Systems (II) (Thursday May 22, 2014 1:30-3:00) Room: BV 3.328

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Daniel W. Steeneck, Jonathan G. Flittner, and Subhash C. Sarin
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António Almeida and Américo Azevedo
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T31. Product Development (II) (Thursday May 22, 2014 3:30-5:00) Room: BV 1.312

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Yueh-Shao Lin, Ming-Chia Yang, I-Wen Peter Chen, and YiWen Chen
"Optimizing the Morphing Displacement of Sandwiched Nanotube Buckypaper Actuators via Design of Experiments Methodology"

David Han
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N Seyajah, K Cheng, and R Bateman
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T32. Production Planning & Scheduling (II) (Thursday May 22, 2014 3:30-5:00) Room: BV 1.318

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Tasnim Ibn Faiz and Bhaba R. Sarker
"Minimization of Transportation and Installation Time for Offshore Wind Turbines"

Prinz, C.; Jentsch, D.; Kreggenfeld, N; Morlock, F.; Merkel, A.; Müller, E.; Kreimeier, D
"Concept of Semi-Autonomous Production Planning and Decision Support Based on Virtual Technology"

Saifaddeen Sallam, Mohammad Munir Ahmad and Mohamed Nasr
"Development of Predictive Production Model for Increasing Productivity of Oil Wells"

T33. Lean Manufacturing & Operations (Thursday May 22, 2014 3:30-5:00) Room: BV 3.324

Chris Bain and F. Frank Chen
"Development and Implementation of Value Stream Income Statements in Support of A Company's Lean Transformation"

Tatiany M. da Silva and Joao C.E. Ferreira
"Value Stream Mapping and Discrete Event Simulation Applied to Reduce Waste in a Company that Manufactures a Family of Automotive Parts"

Fernanda A. Breitenbach and Joao C.E. Ferreira
"Application of Lean Manufacturing Concepts and Value Stream Mapping to a Company that Manufactures Engineering To Order Road Transportation Products"

Leonardo Rivera
"Applying Lean Manufacturing Tools to the Management of Operational and Network Risks"

T34. Green Manufacturing & Sustainability (Thursday May 22, 2014 3:30-5:00) Room: BV 3.326

Sasha Shahbazi, Carina Sjödin, Marcus Bjelkemyr, and Magnus Wiktorsson
"A Foresight Study on Future Trends Influencing Material Consumption and Waste Generation in Production"

Akshit Singh, Nishikant Mishra, and Steve McGuire
"Waste Minimization at Abattoir and Processor end in Beef Supply Chain"

Minna Lanz, Eeva Järvenpää, Hasse Nylund, Reijo Tuokko, Seppo Torvinen and Konstantinos Georgoulias
"Sustainability and Performance Indicators Landscape"

Zhang Jian and Hong Yang
"Research on Green Innovation of the Tyre Manufacturers in China based on System Dynamics"

T35. Logistics & Distribution (Thursday May 22, 2014 3:30-5:00) Room: BV 3.328

Jing Chen, Ming Dong, and F. Frank Chen
"A model for integrating shipment consolidation and pricing decisions in perishable product supply chains"

Amin Mirkouei and Karl R. Haapala
"Integration of Machine Learning and Mathematical Programming Methods into the Biomass Feedstock Supplier Selection Process"

Krishan Rana
"An Intercontinental Multi-modal Distribution model for Containerized goods"

Shan-Shan Wu and De-yuan Wang
"An Approach of One-item-multiple-code for Logistics Management in International Power Generation EPC Projects"

F11. Lean Manufacturing & Operations (Friday May 23, 2014 10:30-11:40) Room: BV 1.312

Jun-Ing Ker, Chandra Mani Shrestha, Yichuan Wang, and Hung-Yu Lee
"Implementing Lean Manufacturing to Improve Compressed Gas and Liquid Filling Efficiency"

Farnaz Ganjeizadeh, Helen Zong, Pinar Ozcan, and Erik Olivar
"Effectiveness Comparison between Kanban and Scrum on Software Development Projects"

Rubiano-Ovalle Oscar, Peña-Montoya Claudia and Paz-Roa Juan
"Applying Value Stream Mapping to Improve the Solid Waste Management in Small and Medium Sized Enterprises"

F12. Enterprise management & Analysis (Friday May 23, 2014 10:30-11:40) Room: BV 1.318

Emeka Ojijiagwo and Chike F. Oduoza
"The Economics of Gas Flaring in Oil and Gas Processing Environments: A Case Study of Electric Power Station in a Developing Country"

Johannes Goetz, Joerg Franke, Andreas Mueller-Martin, Markus Forthaus, and Boris Grobholz
"Application of Design Elements for an Engineering Community in a Multi-sector Engineering Company"

Majuri, Matti , Tapaninaho, Mikko, Tuokko, Reijo, Torvinen, Seppo
"Production as a Key Factor for Driving Competitiveness in Manufacturing Industry"

Huang Kun and Zhang Jian
"Research on Life-cycle Process Management of Petroleum Geophysical Exploration Engineering Project in China"

F13. Manufacturing Processes (IV) (Friday May 23, 2014 10:30-11:40) Room: BV 3.324

Huibin Sun and Weilong Niu
"Hilbert-Huang Transform Based Tool Wear Feature Extraction"

Mohd Azlan Suhaimi, Nita Solehati, Joonsoo Bae, and Dong-Won Kim
"Optimization of Plastic Injection Moulding Process using Data Mining: A Case Study"

Tae-gyeong Lee, Jong-min Kim, Eung-young Heo and Cheol-soo Lee
"Parameters Design using Fuzzy Theory in Laser Cutting"

F14. Automation & Equipment Maintence (Friday May 23, 2014 10:30-11:40) Room: BV 3.326

Tomáš Kamaryt, Vladimír Kostelný, André Hurzig and Egon Müller
"Using Innovative Transportation Technologies and Automation Concepts to Improve Key Criteria of Lean Logistics"

Haitham Mansour, Munir Ahmad, Fadala Ahtita
"Practical Evaluation Workover Framework (PEWF) for Evaluation and Process Improvement of Workover Rigs in the Oilfields"

Hendrik Hopf, David Jentsch, Thomas Löffler, Sebastian Horbach, and Angelika C. Bullinger-Hoffmann
"Improving Maintenance Processes with Socio – Cyber-Physical Systems"

Additive Manufacturing, Bio and Biomedical Manufacturing, Web and Cloud-Based Manufacturing

3D Printing with Reusable Voxels: A Faster and Greener Future (52)

Audrey Stipe; HungDa Wan

Department of Mechanical Engineering and Center for Advanced Manufacturing and Lean Systems, University of Texas at San Antonio, San Antonio, TX 78249, U.S.A.

Many of the applications in the 3D printing market have been for manufacturing prototypes in an inexpensive and relatively fast manner. Today, 3D printers make this possible by no longer having to use third party manufacturers. For all of the purposes that 3D printing is used, many of them, such as 3D geographic maps, visual art, model support structures, dioramas, prototypes, do not require a high precession. Furthermore, for such applications, there is no need for permanent prints. Due to the advancements in technology, and its residual pollution from waste, there is a need for a 'greener' method to 3-D printing. To meet this demand, we propose MIRV (Mechanically Interchangeable and Reusable Voxels), for voxel-based printing, a new method for 3-D printing. MIRV uses pre-built volumetric elements to build 3-D objects, by employing specially designed reusable and interchangeable building elements in voxel-based printing. When there is no longer need for the printed object, the object can be disassembled and the parts reused. This eliminates any wasted material. Meanwhile, all building elements of each layer are displaced in one simultaneous motion. Thus, the overall time to build a print can be significantly reduced compared to other 3D printing technologies.

Manufacture and Instrumentation of Bio-Mechanical Shoulder Testing Rig for Medical Applications (61)

David Hughes; Prof Farhad Nabhani; Prof. Simon Hodgson

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Manufacture of medical simulations and devices is complex as parameters are often complex and ill-understood. Until recently the accurate measurement of contact loads acting in the Glenohumeral joint have been difficult to calculate and define. Now, contact forces and moments are measured in-vivo using telemeterized Shoulder implants. This method limits testing opportunities so a dynamic Shoulder testing apparatus has been developed to examine Glenohumeral joint motion and forces. This in-vitro study describes a novel testing arrangement and evaluates the accuracy of forces generated in the Glenohumeral joint using an instrumented prosthetic implant. Forces were applied to cables to simulate loading of the supraspinatus, subscapularis, infraspinatus/teres minor, long head biceps and anterior, middle, and posterior deltoid muscles. The test rig described reproduces the 6DOF of the Glenohumeral joint and accurately recreates the contact forces measured in-vivo. This design will allow many more tests to be simulated including comparison of fixation methods and high impact injuries. As a result of the study it will be possible to make recommendations regarding the biomechanical fixation techniques of the proximal Humerus for varying complexities of fracture, differing bone properties and populations in an attempt to find the optimal treatment to suit each individual patient. It also provides a valuable demonstration of new design and validation techniques used when developing medical simulations and devices.

Study of Network Capability for Cloud Based Control Systems (45)

Jan Schlechtendahl[1]; Zhiqian Sang[1]; Felix Kretschmer[2]; Xun Xu[2]; Armin Lechler[1]

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Current control systems are limited from a technical viewpoint in areas such as scalability, start-up and reconfiguration time and computational complexity for algorithms. These limitations call for a new concept for control systems to address current and future requirements. It has been suggested that the physical location of the control system be moved from that of the machine to a cloud, i.e. Control System as a service (CSaaS). In this way, the control system becomes scalable and can handle highly complex computational tasks while keeping the process know-hows. Utilizing capabilities of modern Wide Area Network (WAN) and Local Area Network (LAN) the control system can be connected with the rest of the machine, e.g. drives, sensors, devices and HMI. This approach, however, presents new challenges, i.e. the requirement for integration of network, cloud computing and control system expertise. This paper will focus on the requirements of the communication for a cloud based control system.

Integrated Monitoring and Control System for Production, Supply Chain and Logistics Operations (71)

Sobhi Mejjaouli1; Radu F. Babiceanu[2]

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[2] Department of Electrical, Computer, Software, and Systems Engineering Embry-Riddle Aeronautical University, Daytona Beach, FL, 32114-3900, USA

Meeting customers' demand with the minimum cost, the required quality, and within the expected timeframe is the ultimatum goal of producers and logistics companies alike. To achieve this goal, real-time supply chain systems decisions are needed to address the inherent production, operations, and market uncertainties. Machine failures impact the producers' ability to meet their scheduled demand. Logistics delays are a significant source of uncertainty, especially when perishable items are transported with direct consequences on delivery time and quality. Real-time condition monitoring for in-transit perishable items requires an adequate infrastructure system available. Two relatively new technologies for the production and logistics domain, RFID and wireless sensor networks, provide the needed sensing, processing, and data storing and communication capabilities. When integrated, the resulting monitoring and control system may allow producers and logistics companies to considerably improve their operations by gaining more visibility for the product movement across their supply chains. This work proposes a framework for the design and implementation of a monitoring and control system for production and transportation operations. The proposed system employs the RFID-wireless sensor networks integration and is intended to provide more flexibility for production, logistics and supply chain activities in the face of uncertainties inherent during operations.

Adaptive Robotic Control in Cloud Environments (102)

Goran Adamson1; Lihui Wang[1, 2]; Magnus Holm[1]; Philip Moore[3]

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[2] Production Engineering, KTH Royal Institute of Technology, Stockholm, SE-10044, Sweden
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The increasing globalization is a trend which forces manufacturing industry of today to focus on more cost-effective manufacturing systems and collaboration within global supply chains and manufacturing networks. Cloud Manufacturing (CM) is evolving as a new manufacturing paradigm to match this trend, enabling the mutually advantageous sharing of resources, knowledge and information between distributed companies and manufacturing units. Providing a framework for collaboration within complex and critical tasks, such as manufacturing and design, it increases the companies' ability to successfully compete on a global marketplace. One of the major, crucial objectives for CM is the coordinated planning, control and execution of discrete manufacturing operations in a collaborative and networked environment. This paper describes the overall concept of adaptive Function Block control of manufacturing equipment in Cloud environments, with the specific focus on robotic assembly operations, and presents Cloud Robotics as "Robot Control-as-a-Service" within CM.

Model for Quality Tracing of Agricultural Products Using RFID and Internet Systems (178)

Meng Yu [1]; Xiejun Zhang[1]; Bhaba R. Sarker[2]; Hui zhi Yi [2] ; Cunrong Li [3]

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Due to nationwide health hazard problems and the development and prevalence of information industry, Internet of Things (IOT)-based traceability system has gradually been applied to agricultural products to monitor the whole process from fields to final consumers, covering production, processing, and sales. This paper first analysis the factors that affect production-based processing enterprises and supermarkets as main patterns of direct link between farmers and supermarkets. A model for tracing the system or factors that affect agriculture product quality is then proposed. Finally, a prototype system is established and its application is discussed by adopting radio frequency identification (RFID) technology, ASP.NET, and Web services technologies, with Visual Studio as the software development platform and SQL Server as the backstage database. The RFID is used here as an aid to gather product information. The importance of the system developed in this study lies in as follows: firstly, this system can realize the effective traceability of the whole process for agricultural products from the origin to final customers through the processing enterprises and supermarkets; secondly, adaptation of this system enables the transparency of the agricultural product information and, thus, the enterprises can be better managed; lastly, this system enhances the safety, consciousness of consumers, and supervision of government department for agricultural products quality.

Design of a Cost-Effective Wireless System for Estimating Solar Photovoltaics Generation (188)

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With the world moving into a stronger dependence on solar energy through the use of photovoltaic systems, independent variables relating to power output must be understood because relying on solar power for electricity production requires an accurate output prediction to avoid any risk of shortage. It is obvious that the power output of a solar panel is inconsistent and volatile due to variable weather conditions. Weather patterns have a great influence on solar panel output due to the changes in radiation intensity, ambient temperature and even wind speed. By consistently monitoring these parameters around a solar panel, the relationship can be extrapolated and used to predict the actual power output based on the in-situ environmental data. We developed a mobile solar monitoring station integrating a low cost wireless system with versatile functions. A device embedded with multiple sensors was constructed to gather weather data including temperature, light intensity and wind speed adjacent to the solar panel. Real-time data are wirelessly transmitted to an indoor computer server for statistical analysis. After being processed, data are graphically displayed over designated time intervals which can be compared to the actual power measured from the mobile solar station. By understanding this relationship, a reliable solar energy generation process can be tracked and predicted in the presence of weather uncertainty.

Modeling and Simulation of Web-based Virtual Turn-milling Center (211)

Xue-Wei Zhang; Tian-Biao Yu; Wan-Shan Wan; Wei-Li Liang

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To overcome the deficiency of transferring files based on the Internet and expensive computer-aid design (CAD)/computer-aided manufacturing (CAM) software, this paper presents a web-based interactive manufacturing system to model and simulate for the turn-milling center. The system is developed by virtual reality modeling language (VRML) /JavaScript interaction which could easily transmit the machining simulation files through the Internet. The geometric and kinematic models of the turn-milling center are built to show the machine motion. Based on the turn-milling center model, the key technologies for machining simulation including the material removal process, NC codes compiling, collision detection and cutting forces prediction are developed. The virtual machining process is implemented to validate feasibility of the proposed system. The web-based virtual machining system realizes multiple dynamic demonstrations of turn-milling center, users can comprehensively understand the machined product performance. The research for the web-based virtual system of turn-milling center has important research value and application prospect.

CAD/ CAM/ CIM/ FMS/ and Robotics

Making Product Customization More Feasible for Flexible Manufacturing Systems (39)

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A big challenge for companies is to make the steps between product design and process configuration more agile and adaptable. Some potential areas of performance improvement include; connecting product design to process design and automating the set-up of manufacturing equipment for material handling, machine tools, bar-code readers and vision stations. Progress in these areas will allow for customer requirements to be utilized efficiently in developing instructions for a Flexible Manufacturing System (FMS). The result would be a faster turnaround for new products and changes to customer roles in developing the products. One option is to streamline the creation of routing sheets, work instructions and programs that contain all product information and the strategies for making and inspecting the product. A key to this effort are the Application Programmable Interface (API) tools available in software throughout the product development and manufacturing cycle. If a library of programs can be created and made available for each station in the cell for different product configurations, the API could select and automatically load these programs including data (e.g. tooling, jigs, and fixtures) and make the cell very easy to set-up. A company could increase customer involvement in product development without a huge cost associated with re-configuring the automated system.

Analysis of CNC Software Modules regarding Parallelization Capability (65)

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The software design of current CNC systems is of limited suitability for real parallel execution on multicore systems. Even though CNC systems are rudimentarily designed in a modular way, a good load balancing and therefore an efficient use of multiple processor cores is not satisfactorily to be accomplished, as the modularization is not sophisticated enough. A parallelization of CNC functions and algorithms would remedy this deficit. This paper presents an analysis on which parts of a CNC system show the capability for parallelization. Furthermore an approach is presented on how the parallelization of a specific function, namely the look-ahead function, can be accomplished.

Advanced 3D Robot Simulation for Flexible Interactive Manual Robot Guidance – An eRobotics Approach (111)

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Manual robot guidance is an intuitive approach to teach robots with human's skills in the loop. It is particularly useful to manufacturers because of the high flexibility and low programming efforts. However, manual robot guidance requires compliance control that is generally not available in industrial robots. We address this issue with a simulation-based approach. The dynamics of the robot are replicated and its motion is controlled on the simulator, which is enriched with a joint admittance controller driven in real time with external joint torques sensed during interaction with the physical robot. We then virtually transfer the admittance capability by sending back the simulated compliant joint position to the real robot to enable manual guidance. Experimental case studies are provided to illustrate the practical performance and usefulness of the proposed smooth bidirectional transition between 3D simulation and reality, as pursued by eRobotics to address complex issues in industrial automation.

Implementation of a Force Controller Based On Fuzzy Rule Emulate Networks for Soft Contact with an Object with Unknown Mechanical Properties (156)

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In this article, a novel force control system for soft contact with an object of unknown mechanical properties is proposed by using an ultrasonic sensor implemented in a 3 DOF manipulator robotic system. The emphasis is on the development of a control system to allow soft contact with an object of nonlinear elastic contact properties. In this work a Multi-input Fuzzy Rules Emulate Network (MiFREN) scheme controller with adaptation is developed to regulate the contact force. We propose the use of an ultrasonic sensor in conjunction with a signal conditioning for force based on a parallel-distributed-model as well as the Hertzian model, and considering the transmission and reflection of ultrasonic wave properties. The IF-THEN rules for the MiFREN control are defined taking into account the human knowledge of a physical system and a stability analysis is developed by the Lyapunov method. The experimental results demonstrate that the system is able to find a stable first contact force and moreover the proposed controller is capable of controlling the contact force for both regulation and tracking tasks.

A Fast and Accurate Recognition System for Flexible Grasping of Electronic Goods (194)

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Automated packaging is becoming more and more interesting for various production sites even in Europe. However, in many companies the packaging process can only handle a limited amount of products. This leads to a very inflexible packaging and a bottle neck in the production. Most of the time for new products, the packaging system needs to be modified. One of the main components in an automated packaging process is the recognition and then the grasping of the objects that need to be packed. For different products mostly a different gripping system is required. In this paper, solutions from a research project are presented which enables the recognizing as a basis for flexible grasping of different products. These solutions includes a flexible pose recognition for different objects by a low cost system based on Kinect or or Asus Xtion cameras.

Technologies Guiding the Future of Robotics in Manufacturing (208)

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Industrial robots, both stationary and mobile, have been used in manufacturing applications for decades and are most often employed based on requirements for dedicated and repetitive manufacturing operations. Industrial robot capabilities have continued to advance in areas such as payload, accuracy and speed. Looking to the near-future, the use of robots must also transition to operate in dynamic environments for high-mix low-volume production. A variety of affordable technologies are emerging and blending to bridge the gap between the traditional use of industrial robotics and the future where robots react to consumer-driven customized product demands. This paper is intended to be informational in nature and will present applied technology development to overcome some of the historical limitations in the use of automation for complex industrial tasks. Additionally, this paper will describe internal and industry sponsored research efforts that are giving robots greater intelligence, more flexibility and greater ability to work collaboratively with humans.

Tool Path Generation Considering NC Block-based Machining Stability (223)

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The industrial and increasing requirements of aesthetic products force the shape of product to have the complex 3D shapes. It is common to manufacture such products through three machining steps: rough machining, semi-finishing and finishing. Unlike 2.5D, rough machining step chip formation is different, depending on the tool movement in the machining process. Non-uniform chip load means unbalanced cutting force and the severe change of chip load may increase tool wear and reduce tool life. Although NC-data is generated considering machine dynamics, the irregular chip load may cause tool chatter. Especially, if the NC-data is generated without considering the dynamics of the machine tool, chatter can be created with adverse effects for the machine tool and workpiece. Thus this study proposes a methodology to analyze and generate chatter-free NC-data while maintaining the stability of the tool path. Each NC-block is divided into sections of unit-length NC-blocks and their stability is analyzed. The proposed method is validated through experimental results and is expected to improve machining productivity and quality.

Communication Architecture for Robotic Applications (246)

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In robotic applications, the communication protocol is one of the main features that dictate scalability and network topology. The communication architecture must consider heterogeneity (i.e. network, hardware, operational system and programming language) and provide programming abstraction to simplify its development. There are several middlewares and frameworks that can be applied in robotic applications, differing considerably in complexity, programming languages and approach. In this context, this paper presents a communication architecture that fulfils such requirements and ensures information exchange through the network. It was evolved from a previous study, providing more flexibility and easily to adapt to other applications. An interface definition language (IDL) was conceived that enables users to define and deploy services, and also adjustable constraints (service request timeout, message size, maximum number of connected nodes) that restrict provided functionalities. The middleware is based on a multi-threaded service-oriented hybrid peer-to-peer architecture that uses concepts of object-oriented programming in a layered structure to provide flexibility for the communication implementation, minimizing code changes when ported to other robotic systems. Tests of availability and network response time were performed to evaluate its time constraints. The middleware applicability was proven when implemented in an AGV distributed system, designed to operate an intelligent warehouse.

Enterprise Engineering, Knowledge Management, Production Strategy and Economic Analysis

Ontology Based Virtual Enterprise System Domain Modeling (68)

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A virtual enterprise (VE) is a product oriented temporary consortium which forms a collaboration platform to fulfil a specific common purpose (typically to create a product) by benefiting from various capabilities of multiple VE partner enterprises. VE lifecycle consists of 3 distinct phases including VE Formation, Operation and Dissolution. VE partner enterprises are selected from virtual breeding environment (VBE) based on specific criteria considering the new VE project specifications. In order to select the most appropriate partners for the forthcoming VE project, it is required to have comprehensive information regarding the VBE members, their current conditions, capabilities, capacities and their past performances. This database continuously changes and it is dynamic. Ontologies and the corresponding knowledge bases provide the best tools for modelling such complex domain knowledge and highly dynamic data requirements. Ontologies not only help model and capture complex domain knowledge, but also improve the sharing and reusability of data and knowledge providing a suitable environment for software agents and human communications. The VE system must be able to demonstrate what types of resources exist, where they are located, and how much resource capacity is available to be used by the consortium. In this paper a pilot Virtual Enterprise system model developed for OSTIM organized industrial park in Ankara will be presented in detail. The objective of this system model is to enable SMEs in the region to collaborate effectively in order to produce eco-friendly high value added products.

The Economics of Gas Flaring in Oil and Gas Processing Environments: A Case Study of Electric Power Station in a Developing Country (69)

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Gas flaring continues to pose significant threat to the environment and economy of oil and gas producing countries in particular and the globe in general. This process impacts adversely to the health and safety of the inhabitant of these countries. About 100 Billion Cubic Meters (BCM) of gas is being flared globally on annual basis with Russia and Nigeria flaring more than other countries to the tune of 35.5 and 15.2 BCM, respectively. During oil and gas processing, excess gas that is generated could be managed and beneficially harnessed by systematic channelling of the gas to the power sector where turbines utilize it to generate power. The aim of this study therefore is to investigate the production, distribution, consumption and wastage/misuse of associated gas in a typical gas-processing environment to find out the cost and effect of gas flaring. The methodology adopted to gather data involves case studies, interviews, questionnaires, artefacts and observations. The investigation site has seven gas production wells with an output of 7.2 million cubic meters per day (mmcmd). While 91.7% of this output is supplied to customers for consumption, the remaining 8.3% is controllably flared. The flared quantity increases with reduction in customers' demand and during production down time. It was found in the investigation that an average power station comprising three gas turbines and one steam turbine utilises about 3.0 mmcmd of gas to generate approximately 600-650MW of electricity. Consequently, this research proposes that with the employment of an additional gas turbine, substantial quantity of the flared gas could be sustainably used to generate power if the flaring process is properly managed.

Application of Design Elements for an Engineering Community in a Multi-sector Engineering Company (99)

Johannes Goetz[1]; Joerg Franke[1]; Andreas Mueller-Martin[2]; Markus Forthaus[2]; Boris Grobholz[2]

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The efficient and effective engineering of industrial plants has a high impact on the success of numerous companies. Core of engineering activities is to accurately cover the requirements of the customer and design and build a perfectly fitting solution. Due to the one-time character of these projects, time and money can be saved by a reuse of knowledge from former projects as well as a strong methodology to execute these complex projects. The need for an efficient exchange of knowledge and further development of engineering methods (e.g. resource planning, training concepts, cross-country collaboration) has been recognized by many companies on a top level. At the same time there is currently no consistent approach, how to involve the experience of a broad engineering community in the development and implementation of efficient methods. This work describes an approach which closes the gap between a grown "community of practice" and a top-down initiative for the development of engineering methods and structured knowledge exchange. It ensures the deep involvement of experienced engineers from a vivid community for exchange and feedback. Three formerly described design principles (stakeholders, infrastructure, content and activities) of a community-based initiative have been applied to in a multi-sector engineering company.

Supplier Discovery and Assessment based on Ontology Models for Mold Manufacturers in Korea (126)

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Recently, mold manufacturing companies in Korea try to reinforce their competitiveness and find collaboration partners from overseas. In order to find their collaboration partners, companies participate in various kinds of expositions and conferences, or sometimes use business agents and websites. After revitalizing internet, many companies try to find their collaboration partners via supplier discovery websites such as alibaba.com, mfg.com, and so on. These websites provide general information or engage in business contracts between buyers and suppliers by human force. In such cases, the website users have to pay a lot of money for their membership and contracts. This will be a big barrier for Korea mold manufacturers as well as others to use such websites. Therefore, in this paper, we suggest a web-based business supporting system, referred to as an Excellent Manufacturer Scouting System (EMSS), which is developed to support core business functions including supplier discovery, negotiation, and collaboration between overseas buyers and domestic suppliers. In order to discover collaboration partners, EMSS has been developed based on ontology models including matching algorithms which can ….. In order to evaluate quantitatively, EMSS has assessment models to verify collaboration partners who are candidates of collaboration. Suggested models, algorithms, and EMSS are novel in the area of supplier discovery and assessment especially from the manufacturability point of view.

MES Functionality Extraction through Ontology Mapping (129)

Hwaseop Lee[1]; Kwangyeol Ryu[1]; Yongju Cho[2]; Hyunjei Jo[2]

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Manufacturing companies have been attempting to introduce a manufacturing execution system (MES) in order to increase their productivity and efficiency. However, many problems can interfere with the introduction of an MES, including the diversity of production environments and the wide scope of MES functionalities. To achieve the desired effect by embodying an MES, it is important to design functionalities of MES by comprising essential functionalities that are suitable for manufacturing features of a company. The traditional method to introduce an MES is to engage experts on information systems. The manufacturing field, however, is a huge industrial sector and it consists of uncountable types of production systems. Therefore, the experts themselves cannot even understand features of production fields. The objective of this paper is to propose a method to recommend MES functionalities for individual companies by automatically extracting main functionalities by using an ontology mapping methodology. The proposed method has academic contributions in a sense that the ontology concept is first applied to the design of the MES. Furthermore, practical contributions can be expected from the facts that time and cost can be reduced for introducing MES by using the proposed method.

Using GRAIMOD for Improving Performance of Multi-Product Companies (130)

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European economies have been deeply affected by different crises. The impact of the economic crisis on enterprises is now recognized by everybody. Enterprises are fighting to pull through the present situation and are seeking to be prepared for the post-crisis phase. Enterprises need to reorganize in order to be better adapted to this situation and to integrate new dimensions in their development. GRAI Methodology is one of the three main methodologies (with PERA and CIMOSA) for enterprise modelling. In this paper, the concepts of GRAIMOD a tool for supporting GRAI Methodology is presented. Then a zoom is made on an example related to multi-product companies for defining a reference model according to enterprises of this activity domain. For improving this enterprise performance, a multi-criteria analysis was used by combining quality, cost, lead time but also carbon management, social societal and environmental dimensions.

An Ontological Model and Method for Obsolescence Resolution and Management (159)

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With today's rapid advancement in technologies, commercial high tech components are rendered obsolete more frequently. Such components are often parts of long-life products. Hence, technology obsolescence can make design changes for systems expensive and result in high life-cycle costs. Several tools have been developed to support obsolescence management. While these tools provide benefits and serve as focal points for information related to components, these tools are limited in many respects due to data conflicts, incompleteness and inconsistency. Further, the lack of communication between these tools compounds the limitations making the proactive management of obsolescence even more challenging. This paper addresses gaps in existing tools, by providing a framework capable of integrating heterogeneous sources of information and knowledge that are required to resolve and manage obsolescence. This is implemented through an obsolescence resolution ontological model developed using the ontology editor Protégé. A reasoning method is used to query obsolescence information and resolution strategies to support decision-making. This paper includes two case studies describing results from the application of the ontological model and method and how these facilitate sharing and exchange of knowledge critical to obsolescence management.

Plant Location-allocation for Bio-methane Gas Production Systems (177)

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Bio-methane gas (BMG) draws more attention due to its renewable and cost-effective characteristic. Our paper focuses on the location-allocation problem of building reactors for the BMG production systems. The objective is to minimize the transportation and building cost by optimally select the reactors' locations and assign the reactors to the organic residues that stock at different hubs. The model of the problem resembles a multi-product uncapacitated multi-facility Weber problem. Heuristic based on the variable neighborhood search method is developed to obtain the optimal solution. Illustrative examples are provided to validate the proposed heuristic.

Methodology for Project Risk Assessment Using Bayesian Belief Networks in Engineering Construction Projects (250)

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Engineering construction projects commonly suffer from cost and time overruns, for most of the time because of uncertainties that are not carefully considered during bidding for contracts and budget project planning. These uncertainties place the project at risk of poor quality delivery and also not adhering to the time and budget schedule within the original contractual agreement. A clear focus on risk analysis and its management from the onset is essential to guide project planning and also to achieve optimal performance in construction projects. The research carried out here presents a risk assessment methodology based on the Bayesian belief network, which is an effective tool for knowledge representation and reasoning under conditions of uncertainty, structural learning procedure, combination of different source of knowledge, explicit treatment of uncertainty and support for decision analysis and fast responses for risk assessment. Bayesian belief network therefore, is a scenario planning tool suitable for project risk management because of its systematic and integrated process approach to the analysis of key risk factors affecting project delivery, with a view to predict the worst and best case scenarios and thereby guide project planning. The proposed methodology developed in this study is partly based on knowledge and experiences acquired from experts who are in a position to provide information on the sources of uncertainty, and the causes of uncertain condition with a view to generate optimal response strategies to support a successful project outcome.

Production as a Key Factor for Driving Competitiveness in Manufacturing Industry (251)

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The importance of small and medium sized companies as a leader for globalization has been recognized through various sources. One class of these companies is called the Hidden Champions. A Hidden Champion company thrives to operate as a global leader in a niche market. The competence factors of the hidden champion companies have been identified in a previous research conducted by Hermann Simon. The competence factors do not include or define the role of production or the production strategy. The purpose of this paper is to study the impact of the decision made in production strategy to correspond to the identified competence factors. This study includes a definition of the hidden champion companies and the identified competence factors. Furthermore, this study provides the existing production frameworks for realizing competent production and production strategy. The results of this research will be later validated through a questionnaire survey conducted in both Finnish and German companies. The final goal of this approach is to provide comparative and timely accurate results of the current state of practice within the SME industry in both Finland and Germany. The study will finally provide information and applicable results for both the industry and academia by defining the dimensions of successful strategies and practices to organize production in the SME industry. The results could be used to define new and alter existing production strategies to improve SMEs' capability to better response to the demands of global markets. Additionally the study will finally generate new information in the Hidden Champion domain by providing results and information of the role of production and production strategy decisions of the global market leaders operating in niche markets. This may inspire the academia to use this information to include alternative perspectives to research.

How to Use the Management Tools in Enterprises: Initial Evidence about Use and Key Drivers of Management Tools among Employees (253)

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The main purpose of this paper is to examine the frequency, patterns and key drivers of the usage of the top ten management tools in enterprises in two Central Europe emerging economies. Data were collected from 155 employees in Slovenian and 185 employees from Croatian enterprises. International comparison reveals that the top management tools used world-wide are not among the most used tools in Slovenian and Croatian enterprises. Comparison of Slovenia and Croatia enterprises reveals similar intensity, but different patterns of the use of management tools between the two emerging economies compared. Regarding the impact of tools drivers it is evident that only education is a highly significant predictor of tool use in Slovenian enterprises, while not in Croatia. The effect of other remaining tool drivers is mainly weak and insignificant. Findings of this study suggest directions for use and future selection of management tools in enterprises.

A Framework to Support the Lifecycle of Virtual Manufacturing Enterprises (256)

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This paper proposes a framework to support the full virtual manufacturing enterprise lifecycle from the creation to the operation and dissolution. The paper will show how the framework supports the activities involved in the setup of virtual manufacturing enterprise, how to run it and which tools are needed. Three main perspectives are considered: knowledge and information, methodology and Technology. A business case analysis is then presented in order to understand the framework applicability to the development of collaborative business opportunities in an engineer-to-order and one-of-a-kind production environments, which is common to a large number of SMEs.

Green Manufacturing, Sustainability and Energy Efficiency

Economic and Ecologic Assessment within Small and Medium-sized Enterprises to increase Industrial Resource Efficiency (15)

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Today the yearly amount of material used in the manufacturing industry reaches a value of 500 billion euros with an inherent potential for further savings of about 20%. The discussed, multilevel EcoX-assessment is a proven measure to increase the urgently needed process transparency of producing companies and allows a sensitization of the corresponding stakeholders at the same time. Therefore, all necessary production steps, beginning from the provision of raw material stage up to the delivery of the final product are analyzed and structured. A visually attractive and easily comprehensible evaluation of the occurring resource flows and generated value-reducing performances (from an ecological and economical point of view) are provided on this basis. The logical consequence is the identification of so-called HotSpots, which indicate necessary optimization measures and directly prioritize these according to the expected performance or effort.

Structuring Energy Efficiency Measures in Manufacturing Industry (101)

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Energy efficiency is an important objective in manufacturing because of political, environmental and economic reasons. A variety of energy efficiency measures is applicable in factory systems, which makes it necessary to structure the measures. A methodical approach to identify and provide energy efficiency measures in manufacturing industry was developed and is briefly described in this paper. A main prerequisite for applying this approach lies in structuring criteria for energy efficiency information. Therefore, this paper describes structuring criteria for both energy efficiency measures and energy efficiency information based on a literature review. The results form a basis to select appropriate energy efficiency measures in different industrial applications.

A Foresight Study on Future Trends Influencing Material Consumption and Waste Generation in Production (125)

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There are boundless upcoming factors that influence future of material waste in production. This broad range of factors needs to be scanned, categorized and analyzed in a structured way. This paper by a foresight study, aims to give an insight and increase awareness about external macro-level future trends concerning raw material consumption and waste generation in production. A limited pilot study indicated that technological forecasting and some reaction upon obvious trends are being taken, although in an ad hoc manner and without structured tools. However, political influences, economic visions and social-cultural shifts were seldom or never discussed. External macro trends and tendencies were examined through PEST analysis to identify potentials and opportunities influencing strategic decisions and innovation initiatives. It is vital to understand the whole picture of possible changes and not only considering the technological trends, but also other relevant development areas that might affect production in different ways.

A Novel Engineering Method for the Power Flow Assessment in Servo-actuated Automated Machinery (138)

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Multipurpose and programmable servo-actuated mechanisms may be envisaged as the key technology for increasing flexibility and re-configurability of modern automated machinery. Unfortunately, based on the current state-of-the-art, these mechatronic devices are extremely flexible but generally energy intensive, thus compromising the overall system sustainability. Nonetheless, the system power consumption can be partially reduced if energy optimality is introduced as a design goal along with the global productivity. Naturally, as a first step towards the practical implementation of any energy-optimality criterion, the end user should be capable of predicting the system power flow, including the major sources of energy loss. In this context, this paper firstly presents a reliable model of a servo-actuated mechanism accounting for linkage, electric motor and power converter behavior. Then, a novel identification method is discussed, which allows the separate determination of the models parameters by means of non-invasive experimental measures. The method is finally validated by comparing predicted and actual power flows in a simple mechatronic system, which is composed of a slider-crank mechanism directly coupled with a position-controlled permanent magnet synchronous motor.

Optimization of Cutting Parameters for Parallel Machine Scheduling with Constrained Power Demand Peak (143)

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Most of the past studies regarding machining optimization were based on machining science and economic considerations without the environmental dimension. Machining with higher cutting speed is usually desirable considering productivity, but requires high power load peak. In Taiwan, electricity price goes up sharply if the instantaneous power demand is over the contract capacity. Production scheduling problems have been widely studied for decades. However, majority of these studies consider jobs are known and processing times are certain. Besides, traditional sequencing and scheduling models deals with the economic objectives. There is still a severe lack of environmental considerations for production scheduling problems. In this study, we deal with a production scheduling problem for a manufacturing system with a bounded power demand peak. It is necessary to simultaneously determine proper cutting conditions for jobs and assign them to machines for processing without exceeding the electricity load limit at any point of time. A two-stage heuristic approach is proposed to solve the parallel machine scheduling problem with the goal of minimizing makespan. An illustrated instance with 3 machines and 20 jobs, each job in details with four possible cutting parameter settings for selection, is studied and employed to investigate the performance of the proposed heuristic.

Waste Minimization at Abattoir and Processor end in Beef Supply Chain (163)

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The UK beef industry holds around 12% value of total agriculture in UK. However, it is currently suffering because of some series of events in the past like outbreak of BSE (Bovine Spongiform Encephalopathy), Foot and Mouth disease and reforms in CAP (Common Agriculture Policy). These events led to the ban on exports of British Beef, loss of headage subsidies of beef farmers and significant fall in demand of beef within the UK. The revenue of beef industry could be highly compensated by minimizing the waste in beef supply chain. According to a report by Food Chain Centre (UK), around 20% of costs incurred within the beef supply chain adds no value. It is a major concern for beef sector considering they are already in crisis as mentioned above. This article focuses on identification of root cause of waste in beef supply chain at abattoir and processor end. Thereafter, certain good management and operation practices are recommended to cope with the waste in beef supply chain. These good practices will boost the sinking fortunes of beef industry and create value for customers. These practices will further help in reducing the environmental pollution caused by the meat wastes.

Sustainability and Performance Indicators Landscape (187)

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The research aims to improve information flow management, by offering more transparent information exchange methods, tools and technologies. While the main target is towards new kind of information and communication technologies (ICT) and systems, the work starts by defining a set of Performance Indicators (PIs) and Sustainability Metrics that are needed in the factory floor and management levels. Today performance indicators and sustainability metrics are measured in various manners in manufacturing companies. Some of the metrics and indicators are suitable only for company level while others are more specific and visible in the factory floor. The paper will categorize the metrics and indicators according its relevance to factory levels (such as operator, cell/line, company and society) and by their measurability and preciseness. Analysis is carried out with a network analysis tool for showing clusters of most important metrics.

Constant Power Production and Harvesting Using Roof Ventilation Systems (196)

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Energy harvesting using horizontal wind turbines is investigated and a performance analysis is done and compared over a period of time using identical rooftop wind turbines. In many buildings, especially high rises, air ventilation systems are operated non-stop with a constant air speed. Real time applications are mainly used with vertical wind turbines, but they have limited efficiency due to wind airflow distribution. Small modifications on wind turbines and ventilator systems can improve the airflow of the vent systems as well as the efficiency of the wind turbine. Using ventilator systems can eliminate weather prediction modelling due to constant airflow and non-stop operation of the ventilator systems. This study shows that even though wind airflow may be stronger at various times during the day, the average power production using a ventilator system is quite large. The ventilator systems can be named a new renewable energy source due to their constant energy production possibilities.

Research on Green Innovation of the Tyre Manufacturers in China based on System Dynamics (234)

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In recent years, the green manufacturing is gradually becoming an important force in the development of automobile manufacturing enterprises in China. How to implement green manufacturing engineering through the green innovation is a realistic problem of China's automobile parts manufacturers. In this paper, green innovation system of tyre manufacturers in China has been analyzed from manufacturers, market and government. Furthmore, the model of green innovation of tyre manufacturers based on system dynamics has been established. According to the research data obtained from Cooper Chengshan (Shandong) Tyre Company in China, the dynamic simulation has been performed. With the estimation, related policy implications and measures required to realize the sustainable development of tyre manufacturers in China have been also discussed. The author believes that the green innovation is beneficial to resource saving, energy saving and environmental friendly in automobile manufacturing enterprises.

Industry Safety, Ergonomics and Human Factors

A Comparative Study between PSI and AHP in the Selection of Safety Devices in Industrial Environments (14)

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In industrial environments there is always a need to use safety devices to reduce the potential hazards associated with machines and equipment. Selecting the most suitable types of safety devices is an important issue which needs to be solved. Although many decision making tools can be used in this process, the complexity and sensitivity of these tools hinder their utilization. This paper presents the application of the Preference Selection Index (PSI) as a comprehensive and simple alternative decision making tool for the process of selecting the most appropriate types of safety devices in industrial environments and compares it against the Analytic Hierarchy Process (AHP). The simple techniques associated with using PSI give it the ability to achieve an effective result while eliminating many of the steps required by AHP. All that is needed in PSI is to evaluate the alternative devices against selection criteria without the need to assign relative importance between these criteria. To validate the advantages of PSI in such a context, it is compared with the results obtained from a study on the application of AHP in selecting safety devices. The same criteria and alternatives are used to select the best device using both AHP and PSI. Four alternative devices and fifteen criteria were used. It is found that PSI leads to selecting the same best device with a slight difference in the final weights of the other alternatives. PSI led to the same final result using one matrix while eliminating the time needed for building seventeen matrices and the evaluation of their consistency required by AHP.

Creating Realistic Human Model Motion by Hybrid Motion Capturing Interfaced with the Digital Environment (50)

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A key challenge in production engineering projects is to achieve significant time and cost savings through early validation of manual assembly operations. Nevertheless, the use of digital human models for dynamic analyses is not very prevalent because of the high modeling complexity in the digital environment: with existing simulation tools, the worker's motions are either unrealistic or too time-consuming to program. Hence, further research is needed for developing a time-saving and realistic human motion simulation. In this article, we present an experimental setup for the early validation of manufacturing tasks through interactive simulation. We use a new hybrid motion-capture system interfaced with the digital environment, which facilitates the generation of realistic human model motion in real time. The software platform used is DELMIA V5. The article describes the relationship between optical and inertial tracking, and how the drift of the inertial sensors can be compensated by using a kinematic chain with a human model. Sequences of postures can be saved, both for the human model and tools, and later replayed synchronously. Finally, we detail the use of our setup in a real-world scenario within automotive manufacturing. This article acts as a practical contribution to simulation-based Manufacturing Ergonomics and Human Factors, illustrating the effectiveness of state-of-the-art technology for viable cost and time savings.

Applied Human Factors Engineering in Advanced Vehicle Design for Elder and Handicapped People (145)

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Barrier-free facilities are necessary for the sustainable development of the country. This paper studied the needs of the elder and the handicapped people in the barrier-free facilities. It found that the elder and handicapped people such as wheelchair users were hard to enter and leave the vehicle because of posture problems. Although barrier-free design was considered in some models of vehicle, however, it is not generally used. The feasible design of portable vehicle seat was studied through the survey and anthropometry measurement. The human factors engineering analysis was applied in the prototype design of movable ergonomic seat. The posture problems were considered when the elder or wheelchair users needed to enter or leave the vehicle. This advanced design can provide a car chair that is safer, more comfortable, and more convenience to meet the needs of elder and wheelchair users. The prototype of movable ergonomic seat was tested. This prototype can support the ingress process and egress process. It can move the seat up, and then rotate 90 degree anticlockwise. When the seat is pushed close to the door, the elder and wheelchair users can easily leave the vehicle. If the elder and wheelchair people needs to enter the vehicle, the movable seat will move up, rotate 90 degree anticlockwise, and move close the door first. The user can easily and comfortably sit on the seat. The movable seat can move back, and then rotate 90 degree clockwise. The final step is to move down. Therefore, the elder and wheelchair users do not need to rise up their hands, shoulders and legs, and they can easily enter and leave the vehicle. Since this design is portable, so it will be suitable to apply in different models of vehicle. Thus, more elder and wheelchair users can be benefited by this ergonomic design.

Factory Control and Planning, Smart and Digital Factory

H∞ Fault Detection Filter Design for Networked Control Systems in the Continuous-time Domain (16)

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This paper deals with the problem of fault detection filter design for a class of networked control systems. Under the assumptions of network-induced time delay being unknown but bounded, packet dropouts and packets out of sequence being unavoidable, a system model for networked control system is firstly introduced in the continuous-time domain. Then an observer-based H∞ fault detection is formulated and, by applying the Lyapunov-Krasovskii functional approach, a delay-dependent sufficient condition on the existence of the H∞ fault detection filter (FDF) is derived in terms of matrix inequality. Furthermore, an algorithm is proposed to get a feasible solution to the H∞ fault detection filter gain matrices in terms of linear matrix inequalities (LMIs) using a cone complementary technology. A simulation example is given to demonstrate the effectiveness of the proposed method.

Methodological Implementation of Sensor Networks for Smart Manufacturing and Smart Factories (77)

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With the transformation to "Industry 4.0", companies are faced with new challenges in the production created by intelligent networking. Flexible information gathering as well as the distribution and supply of information are needed. High economic potentials by the usage of sensor networks in factories and production systems are expected. It is necessary to standardize procedures for assessing the increased demands for sensors and their implementation in the factory. A main problem is the gap with regards to the contents of the two technical areas Factory Planning/Factory Management and Sensor Technology. This article describes procedures for the integration of sensors in production systems as well as procedures for the development of sensors and sensor networks. The significant differences between both areas are the separated consideration of the two areas out of macro perspective and micro perspective. It is essential to define interfaces in planning and development strategies of both fields to attain sensor-based factories and facilities efficiently and also to show possible benefits of those considerations. The combined design process of systems and sensor technology can help to handle the diversity of interfaces in the implementation process of sensor systems and will also lead to a higher level of system integration.

Methodology for the Development of Modular Factory Systems (107)

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Due to a permanently increasing globalization and shorter product and technology life cycles, companies are forced to a continuous optimization of their production. This leads to a huge number of factory planning projects, which can range from smaller modifications in existing plants to a whole new construction of production sites. Recent studies show that such projects often fail to achieve their cost and time targets, whereas the quality of the planning result is mainly accomplished. These facts call for efficient methods to minimize costs and time requirements in factory planning projects. As factories can be considered as very complex and durable products, an analysis of existing approaches in product development processes should be conducted. An important approach in this field of research is the concept of modular product structures, which speed up the development process and help to reduce planning costs at the same time. In this paper a methodology will be presented, which uses approaches from product development and applies them in the field of factory planning. At the same time also concepts from modular factory planning are applied in this paper so that the particular advantages of both disciplines are used in this new methodology.

Benefit of Integrated Agent-based Simulation in Smart Factories to Reduce Resource Consumption of Interlinked Production Lines (151)

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The topic “Industry 4.0” is a key project of the German Ministry of Education and Research. In particular, researchers expect a substantial potential for optimization regarding "cyber-physical systems" (CPS). The embedded systems push ahead the “smart factory” and link production sites on a global scale. The techniques of the “Digital Factory” offer an ideal supplement in this environment to provide additional insights to networked CPS. The “Digital Factory” and its utilities will need to be integrated as a key driver of innovation in this environment. Especially the identified production technology megatrend "resource efficiency" is linked to great expectations of future production. The contribution derives a new framework for industrial communication to integrate the “Digital Factory” as an agent-based connector between real and virtual production. A simulation model is developed to represent interlinked production lines, in which real plant data are validated and compared with the design data of the manufacturer. With this simulation model, resource-optimized control loops are designed which are based on the existing plant technology. The focus of this modelling approach is, not only to be limited to the integration of the energy consumption, but also to cover any other resource.

Learning Factories as Enablers of a Smart Production (181)

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Learning factories have been developed to impart substantial knowledge about improvement processes and methods to students and especially industrial participants within a real-world manufacturing environment. More and more companies are convinced of this concept, which is why they are focusing on learning factories to qualify their specialists from the shop floor to the top floor. The principal aim of learning factories is to convey their participants a complex view of business processes and impart methods, concepts and tools which enable them to detect improvement potentials and to implement more efficient processes in their own production environment. In their early beginnings, learning factories concentrated mainly on the aspects of traditional lean management. Due to the rising significance of resource efficiency (energy and material), this issue has become another main driver for learning factories. This contribution will incorporate the concept of the Learning Factory at the Chair of Production Systems of the Ruhr-University of Bochum.

Using Innovative Transportation Technologies and Automation Concepts to Improve Key Criteria of Lean Logistics (203)

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Decreasing or entire eliminating all kinds of waste in production systems is one of the main goals of today´s companies implementing lean management. Wastes can be found in material warehouses or facilities, all production and logistic processes and in finished products warehouses. The 4th industrial revolution, widely known as Industrie 4.0, delivers many innovative technologies. All of these solutions are significantly helping to reduce waste and make the company lean. These have to be compared to existing technologies in cases of energetic or time efficiency. The contribution describes two logistics technologies – the AirMove system and Automatic Guided Vehicles. The paper further deals with the comparison of the two logistic technologies in crucial aspects of lean management quality-cost-time. Therefore measurements of energy consumption, time or volume aspects are the necessary tools which are providing needed information. The objective is not the discrediting of one of the technologies, but the relaying of the relevance of lean thinking, drawn by a fundamental comparison of the two technologies. The research will be performed in the experimental and digital factory at Chemnitz University of Technology.

Type-oriented Approach for the Value-optimized Application of Heuristics in Factory Planning (258)

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Recent factory planning projects are facing severe issues, i.e. increasing cost and time pressure and higher frequency of planning projects, resulting in repeated failure to achieve the targets concerning time schedule and costs. Experience from multiple areas, such as operations research, investment planning or even everyday life, shows that heuristics have the capability to reduce the time and cost consumption of solution finding processes while maintaining a good quality of the results. Heuristics are simple techniques or "rules of thumb" which also have the potential to support the solution finding process in factory planning. Today, heuristics are applied in factory planning but the application does not follow a systematic approach. It is based on restricted time and cost budgets of individuals rather than the systematic and value-optimized assignment of scarce resources against the background of the overall project. Furthermore, the impact of heuristics on the target system of a factory planning project, consisting of quality, time schedule and project cost, has not yet been examined. This paper presents a type-oriented approach to support the systematic utilization of heuristics in factory planning. In a first step, empowering characteristics for the application of heuristics in general are identified. These findings are then transferred to the field of factory planning. The result is a morphological matrix that facilitates the classification of factory planning projects with reference to their suitability for the use of heuristic methods. Based on the matrix, several factory planning projects are examined and classified to derive reference types that indicate the potential of the successful application of heuristics.

Industrial Automation and Process Control

Towards Proper-Inconsistency in Weldability Prediction using k-Nearest Neighbor Regression and Generalized Regression Neural Network with Mean Acceptable Error (4)

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A significant inconsistency problem exists in the quality of resistance spot welding, and yet it offers various advantages in production. These inconsistent welding data can be eliminated using anomaly detection or instance selection methods. However, in the weldability prediction problem, this inconsistency we refer to as proper-inconsistency, may not be eliminated since it can be used to extract additional information. In this research, we examine the effects of this inconsistency on prediction performance using two machine learning methods, k-Nearest Neighbors (kNN) regression and Generalized Regression Neural Network, in order to identify an approach towards tackling the proper-inconsistency problem in weldability prediction. We also propose a new prediction performance measure, Mean Acceptable Error (MACE), for prediction models in the presence of proper-inconsistency. The proposed method is tested with actual weldability test data.

Controlling of Diagnostic Process When Failures in Manufacturing Process Occur (91)

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The paper deals with controlling of diagnostic processes when failures in manufacturing process occur. The aim is to make an experiment and try to prove that "failure diagnostics" can be controlled. We will focused on developing some precautions which could be used as a tool for controlling and following improvement of diagnostic processes in case of occurring failures. The diagnostics system is an important tool for management set correction and improvement processes. Therefore, it increases their importance and also the effort to their controlling and following improvement on the field of solving problems and failures. The aim of the precautions is to ensure Zero-defect Manufacturing. Our experiment is focused on area of solderability testing because this area is directly connected with manufacturing processes and diagnostic processes have to start for detection of cause of the failure/problem.

An Artificial Neural Network Based on Adaptive Resonance Theory for Fault Classification on an Automated Assembly Machine (205)

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An unsupervised artificial neural network (ANN) based on the ART2-A algorithm is compared to a rule-based method for fault classification on an automated assembly machine. Machine data is collected using three greyscale sensors and two redundant limit switches for 11 different operating conditions. Descriptive features are extracted from the raw data and two data sets, each containing 180 feature vectors, are created for testing both methods. The first data set contains 'real' feature vectors obtained from the original sensor signals, and the second data set contains 'simulated' feature vectors obtained by scaling the 'real' feature vectors. The second data set is used to test the performance of each system when variations are present in the input space. During testing, the rule-based system correctly classified 98.3% of all feature vectors, but its classification thresholds needed to be manually adjusted to accommodate the 'simulated' data set. The ART2-A network perfectly classified the 'real' data set into 13 clusters, and then correctly classified the 'simulated' data into the same 13 clusters without any modification to the algorithm's tuning parameter, vigilance.

Supply Chain and Logistics

A Preliminary Study of the Impact of the Genotype Representation of a Genetic Algorithm on the Supply Chain Design Performance (12)

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The present work reports on the evaluation of various genotype representations in the performance of a Genetic Algorithm applied to a supply chain network design problem that considers manufacturing, distribution, and quality-related costs. The Supply Chain Network Design including Quality Costs (SCND-COQ) model can be used at a strategic planning level to maximize economic profits subject to meeting an overall quality level while satisfying demand and business entities capacities. The SCND-COQ model computes quality costs for the whole supply chain considering the interdependencies among business entities. The SCND-COQ model was used to formulate a constrained Mixed-Integer Nonlinear Programming (MINLP) optimization problem that showed non-convex properties. This fact restricted the use of calculus-based techniques to derive optimal solutions to the problem. To overcome this limitation, the present work provides a metaheuristic solution method based on the Genetic Algorithm (GA) for solving instances of practical and realistic size and compares the performance of different genotype representations of the GA against two exhaustive enumeration-based procedures with calls to global search algorithms. A statistical design of experiments revealed that the genotype representation has profound effects on the performance of the GA-based solution procedure. The main findings and the results of computational testing are reported.

An Approach of One-item-multiple-code for Logistics Management in International Power Generation EPC Projects (35)

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Engineering-Procurement-Construction project type is widely used in the industry of power generation development, and logistics management has been playing an important role in the execution of especially international power generation projects. Logistics in the area of power generation industry can be a very complicated system, typically involving many subcontractors related to logistical activities, requiring countless operations to be completed as well as deals with numerous interfaces between neighboring operations. With the objective of efficient and effective management and control of the whole logistics process, the paper proposes a “one-item-multiple-code” approach to realize the transparency and traceability of logistics management.

A model for integrating shipment consolidation and pricing decisions in perishable product supply chains (38)

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This paper focuses on a simple perishable product supply chain with a vendor and multiple retailers. These retailers, densely dispersed in a distribution zone, are sensitive to price, delivery time and product quality. With the aim of optimizing vendor's average expected profit during a shipment consolidation cycle, an analytical model is proposed for this problem. The upper unbound expressions of optimal time policy and fresh-keeping cost are given based on a certain range of time parameter. Then our theoretical findings are verified by using a numerical case. Some useful managerial insights are obtained based on analyzing the sensitivity of this model on major parameters.

Integration of Machine Learning and Mathematical Programming Methods into the Biomass Feedstock Supplier Selection Process (47)

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Recent concerns over the use of and reliance on fossil fuels have stimulated research efforts in identifying, developing, and selecting alternative energy sources. Biofuels represent a promising replacement for conventional fuels for heating and mobility applications, however, variability in the quality and availability of biomass feedstocks greatly affect the utility of biofuels due to the impact on cost and life cycle environmental performance. Thus, methods for mitigating these potential impacts are needed when selecting biomass feedstock suppliers. In the research herein, the selection of the best supplier is investigated for a biomass supply chain (BSC) network by including both qualitative and quantitative factors. Most existing supplier-selection methods consider four steps: (1) Problem formulation, where Decision-Tree Analysis is applied as a qualitative method for defining the type of biomass feedstock materials for biofuel production, (2) Criteria definition, (3) Pre-evaluation of qualified suppliers, which employs the Support Vector Machine (SVM) method, and (4) Final selection. Integration of machine learning (ML) techniques and a mathematical programming model is undertaken with this method to select the most appropriate feedstock suppliers. It is shown that integrating ML and mathematical programming methods offers a promising approach to supplementing existing supplier selection methods for biomass-to-biofuel supply chains.

An Intercontinental Multi-modal Distribution model for Containerized goods (73)

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Technological advancement, communication facilities and easy of Internet access have made it possible for manufacturers, entrepreneurs, and distributors to have their operations on a global scale. They utilize low labor costs, easy-available land and utilities, and transportation facilities to minimize manufacturing and transportation costs, and increase their bottom line. Goods and services worth two trillion dollars, on an average, cross international borders every single day. Industrial distribution is a four trillion dollar business. This paper describes an intercontinental shipping scenario that necessitates multi-modal transportation systems for distribution of goods. Ships are used between ports of two or more continents, and trucks or railroads are used to transport goods from inland plant locations (sources) to the source-continent seaports and also from the destination-continent seaports to the inland demand points. This is a typical scenario of intercontinental shipping or distribution that is accomplished by using multi-modal transportation system. A mixed integer mathematical programming model is formulated that minimizes the fixed and variable costs from sources to final destinations. The mathematical model is further transformed to a Microsoft Excel model. A numerical test is provided to demonstrate the proposed model and several problems are solved by using SOLVER that yielded an optimal solution. Distribution or logistics companies that have intercontinental operations can easily utilize this model and printout their cargo allocations to various available alternatives and thus become competitive in transporting their industrial products across continents. Intercontinental distribution is a multi-trillion dollar business and even a mere five percent saving in distribution/shipping costs will amount to hundreds of millions of dollars annually.

A Multi-Objective Model for Solar Industry Closed-Loop Supply Chain by Using Particle Swarm Optimization (121)

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The demand on solar energy is decreasing since the government support reduction, moreover, the dramatically increase China solar manufacturers have great impact on solar product price in recent years. Because the insufficient supply of silicon materials carries the issue of solar cell recycle, the solar manufacturer must design a sustainable closed-loop supply chain (CLSC) to recycle and reuse the retired solar cells to achieve 3E (Effective, Efficient, Environmental; 3E) objectives. This paper studies an integrated CLSC network design problem with sustainable concerns in the solar energy industry. We are interested in the logistics flows, capacity expansion and technology investments of existing and potential facilities in the multi-stage CLSC. Therefore, a deterministic multi-objective mixed integer programming model capturing the tradeoffs between the total cost and the carbon dioxide (CO2) emission is developed to tackle the multi-stage CLSC design problem from both economic and environmental perspectives. Due to the multi-objective nature and computational complexity, a multi-objective particle swarm optimization (MOPSO) with novel flow assignment algorithms is designed to search non-dominated /Pareto CLSC design solutions. Finally, a case study of crystalline solar energy industry is illustrated to verify the proposed multi-objective CLSC design model and demonstrate the efficiency of the developed MOPSO algorithm in terms of computational time and solution quality.

A New Stochastic Simulation Optimization Methodology for Supply Chain Inventory Optimization with Imperfect Quality Items (172)

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This paper proposes a new stochastic simulation optimization methodology that integrates meta-heuristic with sample average approximation for supply chain inventory optimization under supply uncertainty. The supply uncertainty specifically considered is quality imperfection/deviation modelled as a discrete or continuous distribution function. In order to approximate the expected total inventory-related cost, sufficient samples of quality deviations are generated and then the corresponding sample average function is optimized by a newly developed hybrid meta-heuristic algorithm. The proposed methodology and its individual components are presented. Numerical results of a single-distributor-multiple-retailer supply chain system with each adopting the (s, S) replenishment policy indicate that the proposed methodology is capable of obtaining high quality supply chain inventory policies with percentage optimality gap within 0.01%.

Impact of Finite Life Cycle to a Consignment Stocking Supply Chain with Uncertain Demand (179)

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There are usually two reasons that force a supply chain to adopt the consignment stocking policy: the high demand variance and the high risk of obsolescence. This research aims to study the influences of these two issues to a consignment stocking integrated supply chain. To better reflect the real situation in the engineering practice, the buyer's warehouse limitation and a reducible lead time is also considered. A five-variable mixed-integer optimization model that aimed to minimize the annual joint total expected cost (JTEC) is developed under the general assumption that the production rate, the number of shipments and the shipping quantities are all fixed. To distinguish the Consignment Stocking policy from traditional ones, the holding cost is considered to consist of a storage component and a financial component. Due to the complexity of the objective function, traditional mathematical methods are cumbersome. As a result, closed-form solutions for the model are not provided. Instead, a novel doubly-hybrid meta-heuristic algorithm is employed to solve the problem. A numerical example is used to illustrate the solution procedure and the efficiency of the doubly-hybrid meta-heuristic algorithm.

Simulation-based Optimization Model for Supply Chains with Disruptions in Transportation (198)

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According to the Office of the United States Trade Representative, U.S. imported agricultural products from Mexico equivalent to $16.4 billion during 2012. Most of them can be classified as perishable and require truck transportation. Long and unpredictable waiting times due to border inspections can be translated in transportation costs for companies in both countries. These waiting times have a higher impact when imported products are perishable. The selection of routes subject to finite transportation resources requires tools designed to improve the system. Optional crossing modals such as direct freight services, transfers, and "fast lane" increase the complexity of the system. Mathematical Programming (MP) models have been developed to solve this problem but they ignore variability on arcs and simplify transportation cost into a single objective function. However, transportation cost involves more than just the freight cost; thus, a single objective function may not be appropriate. Models for the Multi-Objective Shortest Path Problem (SPP) or the Multi-Objective Minimum Cost Flow (MMCF) can optimize several functions. In real life, the length of the transportation disruptions is random and the availability of servers (inspection lanes) changes over time at the different ports of entry; however, previous works assume deterministic attributes. This paper presents a novel Simulation-based Multi-Objective Optimization (SimMOpt) model for minimizing transportation time and cost of agriculture products traded across the U.S.-Mexico border in order to build a resilient supply chain. The proposed SimMOpt stochastic model considers realistic continuous distributions for the service times (inspection times) and availability of inspection servers (lanes) in selected entry ports while optimizing multiple objectives. We present the results of a case study in order to evaluate the performance of the proposed approach.

Inventory Control, Layout and Warehousing

A Study of the Performance of Bucket Brigades when dealing with Multiple Aisles in Warehouses (11)

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Order-picking is where the items are retrieved from the shelves to fulfill customer orders. Order-picking is one of the most costly operations in warehousing accounting for 50-75% of total operating costs (Coyle et al., 1996). This paper presents a novel simulation model that extends the normative order-picking algorithm known as "Bucket Brigades" to address multiple aisles in warehouses and finite walk-back velocity. In order-picking operations, the majority of the previous research works have applied Bucket Brigades over a single-line (serial) system. The contributions of this research work are: (1) an updated literature review of Bucket Brigades using a state-of-the-art-matrix; (2) an extension of the normative bucket brigades model (single-line model) is presented, that is, a multi-aisle model; (3) a comparison between the single-line and multi-aisle models was conducted in order to analyze the difference in performance in terms of worker utilization and order cycle time; and (4) a sensitivity analysis of different parameters and scenarios was performed through a statistical design of experiments. The results of the simulation study are reported and analyzed. The proposed model is flexible and easily extensible to include other real-life warehousing considerations.

User Phase Information Based Inventory Policy for Supply Chain Systems with Remanufacturing (55)

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Most of the literatures for inventory management policies of supply chain systems with remanufacturing had focused solely on warehouse operation. The existence of its optimal policy has yet been confirmed. In addition, the IT platform nowadays has been well developed so that user phase alignment could be executed at relatively low cost and it is a global phenomenon for companies to pursue cross-tier stretch along its value chain. In this study, a supply chain model comprised of three major biz entities (warehouse, remanufacturing facility and user phase) is presented. An optimal (s,S) type policy for this model is first introduced under the non-leadtime assumption and then extended to the leadtime scenario. The theoretically optimal policy is not applicable as a consequence of lacking information with regard to the failure product's return flow. In order to solve this issue, data mining within the user phase is executed and the specification of user phase information that serves to implementing the optimal policy is articulated. Additionally, numerical experiments are presented to verify the optimality of the (s,S) type policy and the contribution of user phase information sharing to inventory cost reduction.

Role of Port Management in Intercontinental Distribution (171)

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A nation's marine transportation system provides an efficient means of moving large quantities of cargo with the least environmental impact. For example, a single 1000-foot ship can move the same quantity of cargo as 2800 trucks, or seven 100-car unit trains. Nevertheless, ships consume the least amount of fuel while resulting in lower air emissions, and a fewer accidents. The role of ports is crucial in the shipping industry. Due to their historic development, unique geographic characteristics, local political infrastructure, constituent commodities, and ever-changing trade patterns, no two ports are the same. In intercontinental distribution, cargo passes through at least two ports. The first port belongs to the source continent and the second to the destination continent. The management of ports plays a significant role in the management and control of transportation cost, total delivery time from the source to the final destination and its variability, cargo security, and reliability of the logistics company, and eventually its throughput. In this paper, we describe various components of the supply chain of the intercontinental distribution with an emphasis on the seaport role and its management techniques. We also describe and analyze various processes that cause delays, and suggest management techniques that help increase throughput of the supply chain. A business process mapping is employed for the analysis of various seaport activities.

Procurement Policy of Vulnerable Parts with Jointly Distributed Lifespan (180)

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Vulnerable parts exist in most machines or equipment. Failure of those vulnerable parts may result in damage of the machine or the product, and may sometimes cause unnecessary down-time within a production cycle, all of which increases the production costs. Therefore, such failures should be minimized and the parts should be replaced at a point before the end of their expected lifespan, which usually follow some kind of distributions and can be known due to its mass usage attributes. On the other hand, too early replacement of the parts also means increased maintenance costs, increased inventory, and increased parts purchasing cost. This study developed a mathematical model to deal with the issue of determining the optimal stopping time of vulnerable tools. Under the preemption situation, a periodic procurement policy is investigated simultaneously to find the optimal order cycle and eventually minimize the total cost. A case study is given to show the feasibility of the model and several parameters are analyzed to show the impact on the total cost and decision variables.

Genetic Algorithm-based Insulation Box Line Layout Optimization for LNG Ship (204)

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To build the first LNG ship in china, production efficiency and cost pose an urgent problem when designs its layout. Considering the real logistics types in insulation box line for LNG ship, a multi-line facility layout problem is first proposed. Then, a genetic algorithm with combinational coding schema and crossover operators is put forward to solve the problem. In this way, both sequence and coordinate of machine can be coded. Accordingly, partial and arithmetic crossovers are used to minimize the logistics cost of box line. In addition, 27 machines with rectangle contours in box pre-processing area are optimized using this algorithm. Through a case study using logistics and size data, the result shows that this genetic algorithm is effective.

Lean and Agile Manufacturing and Operations

Senior Leader Commitment to Continuous Process Improvement: An Exploratory Study of a Military Organization (6)

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Research indicates leadership commitment is an essential ingredient in the successful implementation of continuous process improvement in organizations. The purpose of this qualitative research was to gain a better understanding of the factors that compel senior leaders within organizations to initially consider continuous process improvement, commit to continuous process improvement, and sustain commitment to continuous process improvement. In-depth interviews with senior leaders within a department of the Department of Defense (DoD) were used to investigate the experiences, perceptions, and insights of senior leaders with respect to commitment to continuous improvement. Confirming previous research findings, participants in this study indicated … Participants revealed that continuous process improvement was good for the organization and worth the effort expended. Meaningful results that lead to improved efficiency and effectiveness have a strong influence on a senior leader's willingness to commit to and sustain continuous process improvement. Participants indicated they were committed to continuous process improvement but noted that continuous process improvement can be an administrative burden. Participants asserted that credibility is critical when demonstrating their commitment to other members of the organization. Participants opined that top management must be willing to empower senior leaders to implement challenging or risky solutions. The primary contribution of this research is a better understanding of how senior leaders make the decision to commit to continuous improvement efforts in organizations. With this understanding, top leadership as well as continuous improvement managers can gain and sustain the commitment of senior leaders so vital to the success of continuous process improvement in any organization.

Analysis of a Worker Assignment Model in a Lean Manufacturing Environment (22)

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This paper describes an expansion of a multi-period worker assignment model for a lean production cell that produces a single product family. The hypothetical cell has six workers performing ten tasks during an eight-hour shift, twenty days per month. The model assigns workers to tasks and determines the levels of additional training that may be required to meet customer demand, quality requirements, and cross-training provisions. The two main factors analyzed are the number of workers trained beyond two tasks and the frequency of job rotation. Four levels of worker training and three levels of job rotation frequency are evaluated. To be considered cross-trained, workers must be trained on at least two tasks. The four levels of worker training are all workers minimally cross-trained (i.e., trained on two tasks only), one-third of the workers cross-trained on more than two tasks, two-thirds of the workers cross-trained on more than two tasks, and all workers cross-trained on more than two tasks. The three levels of job rotation are eight, four, and two hour rotations per day. The solutions from the model are analyzed to determine the impact the two factors have on net present costs, quality costs, and training costs within the work month. The model expands upon the authors' previous work, by allowing workers to increase their training by more than a single skill level during the 20-day planning period and by removing the budgetary constraints for training. The results of this model are expected to provide insight on the impact worker training and job rotation frequencies have on production line performance and provide guidance on training policies.

Evaluation of Frameworks Developed which Assist SMEs to Adopt Best Practices (56)

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Due to limitations, whether financial, knowledge and skills, small and medium enterprises (SMEs) are vulnerable to failure when they decide to adopt best practices techniques. Best practices such as Lean tools are considered to be effective improvement approaches to the elimination of waste, in different forms, within processes. Although many studies which have addressed the application of Lean practices in large companies, this is not the case with SMEs. Therefore, the aim of this study is to review the existing frameworks which have been developed in order to assist SMEs to adopt Lean tools; also to develop a framework which can be adopted by SMEs to assist them to implement appropriate Lean tools, and consideration of limitations of SMEs. To achieve this aim, a comprehensive literature review was conducted to review the existing frameworks, followed by developing a theoretical framework appropriate for SMEs to adopt Lean tools. The findings of this study are useful for SMEs as a guide to adopt Lean tools to assist them to avoid the failure experienced by other SMEs. An assessment methodology is presented which brings together the previous developments frameworks for comparison and analysis which will lead to the building of a coherent body of knowledge and open potential for future work. The argument of this paper is that, making decision to select inappropriate lean tool is pure waste. Avoid making the occurrence of such a decision will greatly save resources (time, money) for the company, particularly those SMEs with limited resource. It is intended that the developed model will support the SMEs that are considering the implementation of Lean tools.

An Implementation Procedure for Global Value Stream Management (75)

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The growing volatility in resources and markets, the decreasing half-life of innovation associated with increasingly demanding customers, and the rapid transition of business models, require appropriate strategies. As a result, companies face an increasing number of product types, shorter product lifecycles and the trend to outsource value adding operations to suppliers. Therefore, the complexity involved when optimizing value added networks is strongly growing. To manage this complexity sustainably and improve efficiency, approaches to extend lean manufacturing methods throughout the global value network are necessary. A method to deal with complexity and for sustainable improvement of value added networks is Global Value Stream Management. This paper analyzes the main aspects of the widely used “value stream design method” usually only applied within a single company, in the following called “local”. Based on this analysis, this paper shows, which methodologies can also be used in companies with various sites and value streams extended over various companies (in the following called “global”). It also gives an insight which aspects of the methodology need further development, to be able to manage these global value streams efficiently.

Development and Implementation of Value Stream Income Statements in Support of A Company's Lean Transformation (82)

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The goal of this project was to provide lean income statements specific to Lancer corporation's 11 value streams. A Lean income statement, often referred to as a plain English Profit and Loss statement, is a very easy to read financial statement that does not include allocations or accruals. This format gives value stream managers a straight forward financial report specific to their value stream activities. Several criteria had to be met for the project to be successful. The main two goal s were to only charge the value stream for expenses that were both controllable and measurable, no indirect allocations would be used to assign cost. The second requirement was to not change the company's current accounting methodology. Lancer uses typical standard costing methodology to track and cost inventory within an ERP system. Ultimately the project was successful, real time income statements were made by carving out data from both operational and financial transactions. Aside from some initial organization of expenses and warehouses, no additional data collection was added to support these reports.

Value Stream Mapping and Discrete Event Simulation Applied to Reduce Waste in a Company that Manufactures a Family of Automotive Parts (95)

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Lean manufacturing seeks consistent and complete elimination of waste in order to optimize resources. However, the elimination of such waste in most cases is done through of trial and error, which usually entails more costs for the company. Given this scenario, this paper describes the use of Value Stream Mapping (VSM) and Simulation to a family of products in a company that produces machined parts for the automotive sector. This family corresponds to five models of different cylinder heads that undergo similar processing steps and use similar equipment in their processes. In order to identify waste, initially the current state value stream map of the system that manufactures the family of cylinder heads was developed, and thereafter the future state map was built, seeking to reduce or eliminate waste and implement a lean value stream. The future state map was also modeled in a simulation software, in order to evaluate the proposed improvements in the future state and propose scenarios that enable adequate decision making by the managers of the company, such as the event of an increased demand. The use of simulation together with VSM contributed to provide the following additional advantages to using only VSM: (a) use of random data in the analysis of the results, (b) the possibility of modeling different scenarios without changing the physical arrangement of the production line. The results obtained by applying the methods to the cylinder head manufacturing were: reduced lead time, increase in utilization rates, improvement in visual management, and increased productivity. In addition, the production line started to operate with the amount of operators needed to satisfy the demand.

Application of Lean Manufacturing Concepts and Value Stream Mapping to a Company that Manufactures Engineering To Order Road Transportation Products (96)

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In the current economic scenario, it is an increasing trend companies seeking to adapt their production systems to meet the new market demands, and at the same time to increase efficiency in their processes. Among the various methodologies available, lean manufacturing stands out as a valuable approach to have an efficient supply chain. Lean manufacturing seeks to eliminate waste, and to optimize the company resources. This paper describes the implementation of lean manufacturing concepts in a company that manufactures custom (ETO - Engineering to Order) products for road transportation (e.g. tow truck). Value Stream Mapping (VSM) was applied to one of the products of the company, which has a high variety of parts, materials, and assembly processes. VSM corresponds to a visual representation of the flow of materials and information for a product family, helping: (a) analyze the value stream in the current state, (b) identify the main sources of waste, (c) propose improvements to the current state, (d) add value to the customer. The results obtained were as follows: 75% reduction in storage time of raw materials, 49% reduction in the manufacturing lead time, 80% reduction in transport time of materials and products, 94% reduction in setup time of the assembly area, 75% reduction in waiting time, 50% reduction in positioning time of parts and subassemblies, and 20% reduction in processing time. This shows the potential application of lean concepts in ETO manufacturing environments, and the procedure proposed in this paper can be used as a reference by other similar companies.

Applying Lean Manufacturing Tools to the Management of Operational and Network Risks. (142)

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Risk management has become a growing concern for manufacturers. Academics in the field have classified risks into operational (internal), network (supply chain) and environmental (natural, political and external) risks. Lean Manufacturing tools have been used to standardize and stabilize manufacturing processes, to reduce variability, to increase machine reliability, to incorporate quality into processes and to make the link with suppliers tighter, more efficient and dependable. All of these characteristics suggest that many of the Lean tools could be used to foresee and mitigate risks, and even to react to unexpected events. In this paper we examine the most important lean tools and relate them to the variables that are changed by them. We then examine those variables to identify the risks associated to them and propose a structured procedure for lean practitioners to apply the tools they already are familiar with and take explicit advantage of them in the corporate risk management effort.

Implementing Lean Manufacturing to Improve Compressed Gas and Liquid Filling Efficiency (212)

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The main focus of this study is to apply the Lean concept and methods to help a compressed gas and liquid filling company find the root causes of slow production as well as identify where and how the gas and liquid are lost and suggest methods for improvement. A careful study of the production process was done by analyzing the setups and layout of current work stations, interviewing employees, conducting time study, drawing work flow charts, value stream mapping and measuring the input and output gas amount. Various wastes such as transportation, motion, and waiting were identified, and gas and liquid leaking stations were found. A new plant layout was provided to help the company improve the production efficiency. The results show that these lean manufacturing initiatives had led to a reduction of travel distance, production lead time and factory floor space.

Effectiveness Comparison between Kanban and Scrum on Software Development Projects (241)

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The challenges in managing software development in technology oriented companies have led to different project management methodologies such as Waterfall and Agile approach. Agile methodologies are a group of software development methods that are incremental and iterative. These methods are more effective and important for project management. For the companies that develop complex software, using agile methodologies is particularly important. Kanban and Scrum are two powerful agile project management approaches in software development. The objective of Scrum and Kanban is to help companies work more effectively by telling what to do, how to manage time, how to set-up the team, and finally how to optimize the process. Although these methodologies are significant to companies, a review of literature indicates that there is lack of statistical evidence about which methodology is more effective in terms of budget handling, risk control, quality of the project, available resources, clear project scope and schedule handling. This research investigated the details of Scrum and Kanban and the comparative analysis between them in terms of budget, schedule, risk, resources, scope and quality.

Applying Value Stream Mapping to Improve the Solid Waste Management in Small and Medium Sized Enterprises (259)

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Small and Medium Sized Enterprises (SMEs) should manage the resources they have available in an effective way in order to face the highly competitive environment. In this sense, solid waste (SW) become one of the main issues to be managed, given the possibility of recovering and remanufacturing in internal or external processes. These initiatives are consistent with the policies of environmental responsibility that companies are undertaking. Lean Management is an approach that can be used in order to improve the environmental performance of the SMEs, identifying the source of SW and proposing strategies to reduce or eliminate them. To achieve this, it is possible to use flow analysis tools like the Value Stream Mapping (VSM) to graphically represent the materials with value-added and non-value added. This study is aimed at proposing a methodological approach based on the application of VSM at one plastic manufacturing SMEs by diagnosing the main sources of SW and quantifying them. Weak points on the processes and logistics issues were identified by this approach, providing valuable information for Solid Waste Management (SWM) decisions. The results confirm some advantages of the proposed VSM methodology as a practical redesign tool of waste and materials flows in the value stream.

Machine Tools, Manufacturing Process and Technologies

A Techno-Health Study of the Use of Cutting Fluids and Future Alternatives (25)

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The health issues associated with exposure to cutting fluids is an increasing concern among occupational health researchers. However, this issue has been overlooked in manufacturing enterprises from engineering prospective. The aim of this paper is to provide a multi-disciplinary review of the health issues related to the use of cutting fluids in machining companies and provides some alternative solutions through a series of case studies. The studies indicated that minimum quantity lubrication, biostable oils, cryogenic machining and dry machining are potential alternatives to traditional flood cooling with potential to improve machinability.

A Systematic Design Methodology for Reconfigurable Machine Tools and Controllers for use with Hybrid Manufacturing Processes (32)

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Hybrid manufacturing processes, namely combining multiple processes to interact with the workpiece and each other, have the potential to overcome existing limitations, such as tool accessibility in CNC machining. The synergistic combination of multiple manufacturing processes may greatly benefit from retaining the ability to reconfigure the machine tool. Also, the use of modular control system architectures may provide robust and flexible control over a variety of operating conditions. Although systematic design tools exist to identify hybrid manufacturing processes, there are currently no structured frameworks that may be used to design and validate reconfigurable machine tool and open-architecture control system concepts. This paper seeks to define such a framework, whereby design constraints and requirements may be captured and later used to inform the design process. This paper describes the proposed method, in detail, and provides some illustrative examples of its application in the design of a parallel kinematic reconfigurable machine tool, for use with hybrid manufacturing processes.

Continuous Learning Support Vector Machine to estimate Stability Lobe Diagrams in Milling (37)

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The productivity of milling processes is limited by the occurrence of chatter vibrations. The correlation of the maximum stable cutting depth and the spindle speed can be shown in a stability lobe diagram (SLD). Today it is a great effort to estimate the SLD. Lot´s of experiments are necessary to measure the SLD or derive a detailed mathematical model to calculate the SLD. Moreover not only cutting depth, but also the cutting width should be taken into account. This paper presents an approach to learn the multidimensional stability lobe diagram (MSLD) during the production based on continuously measured signals using a support vector machine. The support vector machine is extended to make it capable for continuous learning and time-variant systems. The process conditions are classified as stable or unstable. The learned MSLDs are very similar to the analytically calculated MSLDs. Changes over time in the system dynamics can also be learned by the proposed algorithm.

Sensitivity Analysis of Wall Coating Thickness to Paint Characteristics in the Spray Painting Process Phase 1: Paint Characterization (59)

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This report represents the first stage of producing a new CFD model capable of calculating paint deposition rate in a robot spray gun for a range of input variables. This will be achieved by analysing the sensitivity of the atomisation and deposition process to each of the major controllable inputs to the system. This report accurately measures the viscosity of several high solid solvent based paints across a range of temperatures and shear rates occurring in industrial spraying processes. Based on a number of practical experiments, statistical regression is used to determine paint viscosity as a function of temperature and applied rate of shear. Results will be used to inform the next stage of computer modelling using measured accurate values for spray paint rheology to better predict spray paint deposition and final film thickness.

Hilbert-Huang Transform Based Tool Wear Feature Extraction (76)

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To deal with the self-adaptability deficiency and high frequency resolution problem of traditional signal process methods in the tool wear monitoring (TCM) field, a Hilbert-Huang Transform based approach is proposed. The intrinsic mode functions (IMFs) and the average amplitude are obtained via decomposing signals by the empirical mode decomposition (EMD) method. Some IMF components that relate to tool wear closely are chosen. The marginal spectrum of single IMF and its maximum amplitude are also found. Referring to the tool wear condition, some strong correlation features are extracted. They are regarded as input vectors of the artificial neural network (ANN). The Hilbert spectra can also been referred to estimate tool wear level. The proposed method is believed to be a simple and reliable feature extraction method for tool wear monitoring.

Optimization of Plastic Injection Moulding Process using Data Mining: A Case Study (81)

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Plastic injection moulding (PIM) process is used for converting plastics from its raw material into a kind of a semi-finish or finish product. PIM is a complex process due to the non-linear behaviour of controllable parameters available in producing high quality product. PIM usually used in a mass production line to support high demand and wide range of products, from as simple as electronic devices to as complicated as aerospace devices. Therefore, it is very important to control products from defects and to gain knowledge about parameters, which will influence to the whole PIM process. For this purpose, this paper presents an optimization of PIM process parameters in a fishing reel production via Data Mining methods. Our previous research done to optimize the parameters using Design of Experiments (DOE) methods proves that the PIM process can be optimized by running 16 experiments by two levels of fractional factorial design. In this paper, Data Mining will be utilized to provide optimal parameters of the PIM machine with desired accuracy. First, the important PIM machine parameter data in fishing reel production were collected. Then, the collected data are analysed using the REPTree Decision Tree method for classification. It is found that, this approach brings out the important decision of PIM machine parameters that are useful in obtaining the desired output results. The results from Data Mining method not only provides the same results as statistical method, but also introduces more efficient quality improvement activities with minimal cost and time consumption.

Balancing Tradeoffs between Machining Time and Energy Consumption for Impeller Rough Machining (92)

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Electrical energy is directly linked to society prosperity across the globe; much of this due to the diverse machining and manufacturing processes. Keeping pace with the high energy demand growth will require constant efforts on investment and research to explore new alternatives. This paper outlines the application of multiple response optimization in order to find a balance in the tradeoff between production time and energy consumption in 5- axis impeller rough machining. It is well known that higher speed reduces the machining time but increases the energy consumption, and vice versa. By utilizing response surface methodology (RSM) together with desirability function it is possible to find a quantitative form of the relationship between outputs and the independent factors involved in the process. Four independent factors were selected, namely, spindle speed, feed rate, depth and width of cut. The responses are consumed energy and machining time. The results showed that selecting an appropriate feed rate is crucial to balance the tradeoffs between energy and time. Spindle speed is the major factor that consumes more energy, while width of cut is the most influential factor on machining time.

Roughing an Impeller: A Review (93)

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Impeller is a rotating device, which transforms fluid flow from axial to radial direction. It consists of several identical, twisted blades with ruled surfaces, which are attached to a hub surface. Commonly, impeller needs high-speed rotation in order to increase the pressure flow of a pump or turbine engine. High machining accuracy is vital in producing an impeller. In this sense, there are many issues in producing a high quality impeller. Not enough information has been provided to guide new researchers in this field in the meantime. To overcome this problem, therefore, this paper reviews existing researches associated with impeller machining, focusing on the roughing strategies. An extensive study covers the literature from 1970 to 2013, mapping out research issues regarding roughing strategy in details. This paper classifies the impeller roughing strategy issues in a chronological order according to the main idea and issues. A clear analysis of machining strategies provided by dividing them into 4 categories; (1) improving machining time, (2) avoiding tool collisions, (3) undercut avoidance, and (4) chatter avoidance. Critics on the existing work and research trends reported as discussions and conclusion.

Rough-Cut Machining an Impeller with 3-Axis and 5-Axis NC Machines (94)

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This study presents an efficient rough-cutting strategy for machining a centrifugal impeller. Much of the machining time is consumed in rough cutting, where unnecessary stock materials are removed in between impeller blades. Thus, most of researchers focus on 5-axis rough machining of an impeller, controlling all the five axes simultaneously as fast as possible. In previous research, we introduced a 3-axis machining strategy that removes as much material as possible from the areas between blades. Thus, the main purpose of the research was to improve the machining efficiency by reducing the machining time. We achieved 19 percent of total machining time reduction by using the 3-axis rough machining. This paper further introduce an improved 3-axis machining strategy by applying feed-rate scheduling for more efficient rough cutting. There are two types of feed rate scheduling, namely, cutting force and material removal rate based scheduling. This research will focus on feed-rate scheduling based on cutting force to increase the feed-rate onto an allowable level. Current research in feed-rate scheduling applies cutting force calculations for each cutter-workpiece engagement, experimenting with different depth-of-cut layers. In this paper, we calculate cutting force for each cutter-workpiece engagement by employing a finite element method. Cutting tool and workpiece geometry will be meshed and analyzed to find out best feed-rate scheduling. The rest of material left from the 3-axis machining will be removed by 5-axis machining. The result shows that by applying this hybrid roughing strategy, the total rough machining time can be reduced significantly up to 43 percent.

Auto-recovery from Machining Stoppages based on STEP-NC (118)

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Machining stoppage occurs from time to time due to various reasons. For the current CNC system using G/M code as part program, to recovery from the stoppage, the operator needs to scroll the part program to find the specific lines where the stoppage happens and make changes to it, because the part program only contains low level machining information, i.e. tool-paths. This process highly relies on operator's experience and is time-consuming. STEP-NC as a new standard for part program defines the machining of a workpiece by workingsteps of machining features, which include geometry information and machining strategy for each feature. Helped by that information in STEP-NC part program, the system is able to plan the retracting toolpath, use different strategies to recover from the stoppage and even regenerate new toolpath for an alternative cutter if the same one is unavailable. When using traditional CNC system, the machining of unfinished workpiece cannot be resumed by another machine tool due to the G/M code's hardware dependency. However, the feature-level machining history information can be stored in STEP-NC file and transferred to another machine, which will be used for process planning and toolpath generation. After relocating the workpiece coordinate system in the alternative machine, the machining can be resumed.

Eutectic Reaction Diffusion Brazing Process for Joining Aluminum Laminae Microreactors (146)

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This research provides a foundation for manufacturing multi-layered metal laminae with microfluidic, micro-feature devices for use in a high temperature and high pressure environments. A reliable method of joining metal laminae could help make the manufacturing of instant reaction heat exchangers and chemical mixing in a cost effective, reliable, and simplified method. These devices enable faster reaction times, modular scaling of production capacity, on-demand chemical processing, and higher purity products. This could lead to faster rates of adoption of microreactors in industries such as pharmaceuticals, energy, food, and bio-medical. Eutectic brazing avoids damage to internal surface geometries and deformation due to lower temperatures required for bonding compared with higher-temperature joining processes. A new process was developed to combine multiple layers of 6061 aluminum alloy with copper foil interlayers to produce micro-channel micro heat exchangers and reactor devices that could be used for new applications. This process repeatedly produced leak-tight devices. The prototype devices contained overlapping coolant and reactant channel systems arranged perpendicularly within each lamina. Related work suggests that diffused joints are mechanically robust in contrast to the parent materials.

Slump Molding Inexpensive Soda-Lime Glass to Produce Microchannel Arrays (162)

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A slump molding process was developed to form microchannel geometries on the surface of soda-lime glass substrates. The process helped to overcome biological and chemical reactivity associated with current polymer lab-on-a-chip substrates, and permitted the use of low-cost soda-lime glass. A high speed micro mill and UV laser micromachining center produced negative geometries in the graphite mold material used as mold. An electric programmable kiln processed the soda-lime glass through a schedule of firing and cooling. Microchannel dimensions measured 50 μm width x 10 μm depth. The heating and cooling schedule required the soda-lime glass to slump into its final shape to these dimensions was determined and documented. Murine nerve tissue experiments validated the functionality of the slumping process and resultant soda-lime glass device.

ANFIS Based Modeling for Processing Variables' Effects on Coating Properties in Plasma Spraying Process (168)

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In order to model the effect of processing variables including primary gas flow rate, stand-off distance, powder flow rate, and arc current on the plasma spraying coating properties including thickness, porosity and micro-hardness, adaptive neural fuzzy inference system (ANFIS) and neural network based models are proposed to understand the spraying process and estimate process parameters. In order to overcome the difficulty of small size of sample data, bootstrap method is applied for the resampling technique and cross validation is applied for the performance evaluation. The ANFIS model and NN model are compared on the performance metrics of 1) mean square error (MSE), and determination coefficient (R2). The comparisons illustrated that ANFIS based modeling showed significant superiority than the other approach. This may be due to the fact that ANFIS combines the strength of NN's learning capability and fuzzy logic's knowledge interpretation ability. With this ANFIS model and identified control rules, feedback control strategy can be effectively implemented to regulate the coating quality in plasma spraying process.

Analyses of Online Monitoring Signals for a GMAW Process before and after Improvement (170)

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The ability to detect the onset of welding instability is a very powerful tool in welding process monitoring and control. Toward this goal, this study investigates a gas metal arc welding (GMAW) process by analyzing online monitoring signals. Two separate data sets are obtained from the process, which correspond to (a) a stable process after improvement and (b) a relatively unstable process which exhibits spatter and poor weld bead geometry. Voltage, current, wire-feeding speed and line speed signals for both data sets are analyzed and features are extracted from the raw signals using different signal processing techniques. Specifically, phase diagrams, signal distributions, and fast Fourier transform (FFT) methodologies are implemented. The process parameters differ for the data corresponding to the stable and unstable processes rendering the two data sets incomparable. As such, an overlapping region of parameters is selected and this data is used to develop a multi-layer neural network model. The model uses the features extracted to distinguish between the two datasets under the similar input conditions. The trained model is then used to classify data as being from a stable process or an unstable process.

Selective Laser Melting of Aluminium Metal Matrix Composite (200)

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Selective Laser Melting (SLM) is well established as a reliable manufacturing process for its speed of manufacture, resource savings and overall efficiency in processing 'difficult to machine materials' with users able to produce complex parts from various metallic alloys [1]. As the demand stronger and more wear resistant part grow particularly in aerospace and automotive industries, the challenge is then for SLM to produce fully dense homogeneous particulate-reinforced parts from dissimilar materials. Challenges in this instance include differential melting points, morphology of powder particles and homogeneity of the feed material. This work offers a solution to evenly distribute powder particles of dissimilar size reliably across a build platform prior to SLM. It also investigates melting parameters and the microstructure of the resultant parts produced. Results presented demonstrate that there is a significant improvement in delivery of dissimilar sized particles across the build area after alloying of the individual powders to produce a composite powder. Complete melting of the Aluminium alloy was achieved with the SiC solidified in the matrix and increased hardness observed in the composite. Some porosity was observed in the microstructure generated which was considered to be a result of the cooling gradient during the re-solidification of the matrix.

Predicting Material Properties of Flow Formed Work-piece Based on a Finite Deformation Method (224)

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Flow Forming Process is a manufacturing process to deform rotating axis symmetric work-piece with rotating rollers. It is difficult to predict the behaviour of work-piece during the process because the shear and compression deformation occurs simultaneously in the shape of helix along the axis. This study presents a model which can predict the deformed geometric shape and material properties using geometric shape change and material properties of work-piece. This model is based on finite deformation theory, and assumes that the structure of the material is isotropic lattice structure. To simulate the flow forming process, firstly the axial displacement is calculated using the stress-strain relation. And then the radial displacement is calculated using the volume constancy theory. The material properties of flow formed material are easily calculated with the deformed geometry. The presented model is verified by experimenting actually, and a tensile test demonstrates the predicted material properties.

The Machining Parameter Design using Fuzzy Theory in Electrical Discharge Machining Drill (228)

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Electric discharge machining drill (EDM-drill) is a process to machine fine holes. EDM-drill is specially used for drilling of difficult-to-cut materials such as high-strength steel, titanium and cemented carbide processing. The machining parameters of EDM-drill include voltage, PWM (pulse width modulation), machining speed, discharge capability, flushing rate, etc. These machining parameters affect the accuracy of the work-piece, the wear consumption of electrodes, surface roughness and machining time. As there are many machining parameters and machined results of work-pieces, it is difficult to establish the relations between the machining parameters and the results. A fuzzy system is presented to predict the relations. The machining parameters and results are normalized using the principal component analysis (PCA) and expressed as membership function (MF). Fuzzy rules are created by fuzzy rule-base which from MF and fuzzy inference is carried out. By this method, it is possible to obtain reasonably the machining parameters, which is necessary for the required machined results. On other hands, the machined results can also be predicted with the given machining parameters. The proposed fuzzy system is implemented using MATLAB. Actual experiments and Fuzzy inference are carried out in same machining conditions and the results are compared.

AC-Pulse Modulated Electrohydrodynamic (EHD) Direct Printing of Conductive Micro Silver Tracks for Micro-Manufacturing (231)

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This paper presents a direct fabrication of highly conductive silver tracks with sub-20 μm microstructures on glass substrates using electrohydrodynamic jet printing (EHD) based on alternative current (AC) voltage. A new AC-modulated EHD technique is presented and used in directly printing by generating a fine jet through a large electrical potential between the nozzle and substrate. In the presented technique of AC-modulated EHD, when charge accumulates on the ink meniscus at the nozzle, a fine jet down to nano scale can be generated. The variables of fabrication process, like plotting speeds, curing temperature and number of layers, were investigated to achieve reliable jet printing of conductive silver tracks. Topography and electrical property of printed tracks were characterized and verified. By using modulated AC-pulsed voltage, we are capable of printing high resolution continuous patterns on insulating substrates. In the study, we successfully applied EHD for fabrication of highly conductive silver tracks on glass substrate. It was the first time that sub-20 μm silver tracks were demonstrated with resistivity about 3.16 times than bulk silver. The presented technique can be used for direct printing of micro scale electronic circuits and devices.

Improving Lumber Yield using a Dual System (243)

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Rough mills embody the process of cutting up kiln-dried lumber to components used by discrete wood products manufacturers to manufacture products like furniture, kitchen cabinets, flooring, or other items. Rough mills traditionally have either ripped the lumber first (e.g., the lumber is first cut into strips lengthwise) then cut the strips to the required part lengths or they crosscut the lumber first to part lengths (e.g., cutting the lumber to shorter, full width segments) then ripped the segments to the required part widths. Both processes offer advantages and disadvantages and, depending on the input lumber geometry (e.g., size) and the cutting bill requirements (e.g., the size of the resulting components) may result in higher yield for individual cases. Using ROMI 4.1, a rough mill simulator that simulates real-world rough mills and can combine rip and chop operations, this study investigated the potential benefits from using such a dual system. Findings suggest that cutting bills requiring small parts when cutting from lower quality lumber produce better yield when a rip-first approach is used, while cutting bills asking for wide and long parts perform better when material is chopped first. However, in every case, yield can still be improved when the decision to rip or to chop first is made on each individual board.

Design of a Low-Cost Fiber Optical Occlusion Based Automatic Tool Setter for Micro Milling Machine (254)

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The objective of this research is to create an inexpensive, automated tool setter to reduce the overall tool set up time. The project focused on addressing the tool setting in the Z-axis (spindle axis), which is needed for each tool change, and accounts for majority of the total tool setting time. A fiber optic FS-V30M sensor from Keyence that is equipped with a light emitting element and receiving sensor was used. The sensor detects the position of the micro-tool by measuring the light intensity change as the tool crosses the emitted light beam. A bracket was designed and manufactured to mount the sensor onto the workpiece pallet to hold the fiber optic cable. A novel search/detection algorithm was developed and implemented in the CNC machine controller. Controlled experiments were conducted to test the performance of the tool setter. The system achieved 0.6 μm repeatability and 2 μm accuracy across different size of micro-tools. The execution of each tool setting takes about 10 seconds, which is a 80%~90% reduction from the manual tool setting.

Parameters Design using Fuzzy Theory in Laser Cutting (257)

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The super precision machine takes micro-scaled features in optical science, machine work and electronic components. It is the technology which demands super precision within nanometer for the surface of processing. The super precision processing is superior to other mechanical machining for processing of the efficiency and the complicated shape. The surface roughness and kerf width of samples of SUS304 is influenced by laser power, feedrate, thickness of work piece and method of laser output. To improve the process time, the defective products and cut quality, we need to control feedrate and condition of laser power. In this study, want to find the relationship of laser power, feedrate, thickness of work piece and method of laser output and come up with the effective plan for controlling laser output condition. To confirm the effect to laser output condition for thickness of work piece, fold the examination alternating work piece sheet and find out the influences. To normalizing Input parameters and Outputs, utilize Fuzzy theory and the relationship is expressed by the membership function which makes the knowledge base. From the deduction, investigate the influence of Inputs and Outputs. Therefore we can find the value of efficient Input parameter required for the desired processing results. In conclusion, this paper shows the direction which effectively controls the condition of laser cutting process, expects to improve the productivity and to reduce the process time.

A Prototype Web Based Decision Support System for Cutting Parameters Selection based on Machining Features (261)

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In this paper, by studying the knowledge classification and planning of typical machining features of workpiece, in combination with the conventional machining processes, the geometry information of workpiece, feature descriptions, cutting parameters, the decomposition of machining element and other data structures are designed. A data management and decision support system for cutting parameters based on machining features is then established. In addition, the functional modules and the decision-making of typical features' processing are introduced in details. Moreover, a prototype system based on Web browsing mode has been developed. It provides an effective way to manage and select the cutting parameters in the machining process.

Manufacturing Systems and Performance Measurement

Advantages of using Hybrid Manufacturing Platforms to realize Decentralized Manufacture (20)

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Manufacturing has traditionally been the domain of centralised factories, set-up and optimised to make a sole product or product-range. Whilst the in-house efficacy of such systems has been greatly improved due to lean six-sigma methodologies, the wider scale distribution and supply system has undergone little to no transformation over the past century. Previous research pertaining to distributed manufacture, cloud-manufacture and reconfigurable systems has provided several decentralised models using traditional manufacturing capabilities. Though to date they have not been fully realised due to practical limitations. This paper outlines the scope for hybrid manufacturing platforms – using a plurality of processes on a single motion platform, to manufacture products in a decentralised network. Social, economic and environmental ramifications of adopting such a system under particular use cases, such as in shops, community areas or in individual households, are highlighted. The combination of several key processes, including measurement, will allow users to manufacture parts with minimal intervention. A move to personal fabrication would allow greater personalisation and convenience for the end user; however, the issues of copyright and loss of economy of scale would inhibit mass uptake in the near-future. Growing interest by enthusiasts and early adopters will continue to make an impact on the way the populace views manufacture.

A Modular Flexible Scalable and Reconfigurable System for manufacturing of Microsystems based on Additive Manufacturing and E-Printing (26)

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Generative manufacturing technologies are gaining more and more of importance as key enabling technologies in future manufacturing, especially when a flexible scalable manufacturing of small medium series of customized parts is required. The paper describes a new approach for design manufacturing of complex three dimensional components building on a combination of laminated objects manufacturing and e-printing technologies. The micro component is made up of stacks of functionalized layers of polymer films. The concept is currently developed further in the project SMARTLAM, funded by the European Commission. The manufacturing system is based on a modular approach which enables the manufacturing of different small size batches with different modules. Different modules can be combined by defined Hardware and software interfaces. Avoiding time consumable and difficult programming caused by manufacturing a new product a Function-Block Runtime (FORTE) executes generated control application platform-independently and coordinates component module functionalities. The control system will integrate all processes as well as the base platform with features far beyond ordinary PLC systems. One aspect is the use of process data out of the data acquisition system to simulate and optimize the processes. These results are incorporated into the main machine control system. Another aspect is the vision system for flexible quality control and closed-loop positioning control with visual servoing. The

paper shows the first example of manufacturing technologies and demonstrates the control system approach by the example of the control system for alignment of different stacks.

Applying Theory of Constraints to Moving Assembly Lines (57)

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The first step in the Theory of Constraints (TOC) methodology is to identify the constraint. Several methods have been recommended in literature, such as looking for a backup of inventory (i.e., the operation that the inventory is waiting for is the constraint), or using linear programming or other analytical models. Yet, these methods may not be useful in a matured lean environment, which may have moving assembly lines where constraints are not obvious. This paper proposes two new methods for this purpose. The first method, Flow Constraint Analysis, takes a holistic view and evaluates whether the customer's demand is being satisfied. This evaluation is made by comparing the takt times and the cycle times of resources in the manufacturing system in order to identify the constraint(s). The second method, Effective Utilization Analysis, can be employed to pinpoint the location of the system constraint to a specific process or station. The actual production throughput is compared against the ideal capacity of the system to locate the bottleneck. This method is based on the relationship between WIP, bottleneck rate and lead time for a constant work in process (CONWIP) system. A case study of both methods applied to an actual production facility is presented.

Hierarchical Management of a Heterarchical Manufacturing Grid (70)

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Automated manufacturing systems are traditionally hierarchically controlled by a centralized control system. This makes the system deterministic and therefore easier to be optimized for efficient manufacturing of a large number of one single product. However, in modern manufacturing the demand for customization and high-mix, low-volume production is growing. This move is strengthened by the acceptation of 3D printers for industrial products and new technologies that make it easier to reconfigure manufacturing systems. Hence, new paradigms like agile manufacturing, which focuses on a shorter time to market, and flexibility are becoming more important to industry. One of these paradigms is grid manufacturing, which uses a group (grid) of autonomous manufacturing systems that can be controlled as a heterarchy (where every system is autonomous and equal to each other). In this paper the goal is to determine, by simulation, if it is useful to develop a hierarchical entity to reserve some of these systems to partly break the heterarchy. This way it would be easier to optimize performance of manufacturing batch products. To fully utilize a grid it would be of interest to be able to use both hierarchical control, where a hierarchical entity reserves specific manufacturing systems, and heterarchical control, where a product can negotiate with any manufacturing system to complete the next step. Since both hierarchical and heterarchical control have advantages this paper investigates the possibility to dynamically choose one of both strategies, depending on the current demand.

Comparative Analysis between Small Displacement Torsor and Model of Indeterminate Applied On Generated Solution of Reconfigurable Manufacturing System (117)

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Reconfigurable manufacturing system (RMS) is the recent addition in the field of manufacturing system. Different approaches deal with the generation of design solutions of RMS. Keeping in view quality as a key performance indicator there is a necessity to evaluate the generated solutions of RMS. In this work a comparative study between the two methods for evaluation of tolerances is performed. First using an algorithmic approach a three dimensional analysis of generated solutions of RMS is carried out. Secondly the model of the indeterminate is used for the tolerance analysis. In both methods the approach used among the existing ones for the tolerance representation and evaluation is the small displacement torsors (SDT). In order to represent the machining process plans the modified method of graph is chosen. In the algorithmic approach the torsor equations are obtained between the interacting surfaces. Each geometric error is represented as a torsor which are then accumulated. Solutions are classified according to the tolerance values of the parameters. In the second method the gaps and defects of the surfaces are first identified and then are written in the form of torsors. The compatibility equations are obtained by resolving the loop equations. These equations are analyzed to obtain the sources of error and eventually part tolerances are calculated. The above methodologies have wide applications in the generative approach for process planning of RMS. They provide a direct link between the sources of error and part requirements. The said methodology acts as a feedback system for the capability of the system.

Evaluating the Role of Product Design and Process Time Variability in Determining a Configuration of Disassembly Stations (192)

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The depletion of natural resources has necessitated a better management of resources. One of the methods in this regard has been the reuse of materials and parts from products at the end of their life cycles, which requires a suitable configuration of disassembly systems for an effective operation. In this paper, we compare performances of two types of system configurations: standalone tear-down-stations and disassembly lines. These system configurations are tested for the disassembly of class 8 trucks to recover parts, which are then remanufactured or refurbished for reuse. A key feature of this product, and that of a used product in general that is disassembled, is the uncertainty of the processing time of a disassembly step. This uncertainty can lead to difficulties in proper line balancing, bottlenecks, inefficient use of resources, and generally, reduced throughput. In order to overcome these limitations, in this paper, we investigate the above disassembly facility configurations, and determine how their performances are affected by variability in operation times.

A Performance Estimation Framework for Complex Manufacturing Systems (216)

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To cope with today market challenges and guarantee adequate competitive performances, companies have been decreasing their products life cycles, as well as increasing the number of product varieties and respective services available on their portfolio. Consequently, it has been observed an increasing in complexity in all domains, from product and process development, factory and production planning to factory operation and management. This reality implies that organizations should be able to compile and analyze, in a more agile way, the immense quantity of data generated, as well as apply the suitable tools that, based on this knowledge, will supports stakeholders to take decision envisioning future performance scenarios. Aiming to pursuing this vision was developed a proactive performance management framework, composed by a performance thinking methodology and a performance estimation engine. While the methodology developed is an extension of the Systems Dynamics approach for complex systems' performance management, on the other hand, the performance estimation engine is an innovative IT solution responsible by capturing lagging indicators, as well as estimate future performance behaviors. As main outcome of this research work, it was demonstrated that following a systematic and formal approach, it is possible to identify the feedback loops and respective endogenous and exogenous variables responsible by hindering the systems behavior, in terms of a specific KPI. Moreover, based on this enhanced understanding about manufacturing systems behavior, it was proved to be possible to estimate with high levels of confidence not only the present but also future performance behavior. From the combination of both qualitative and quantitative approaches, it was explored an enhanced learning machine algorithm capable to specify the curve of behavior, characteristic from a specific

manufacturing system, and thus estimate future behaviors based on a set of leading indicators. In order to achieve these objectives, both Neural Networks and Unscented Kalman Filter for nonlinear estimation were applied. Important results and conclusions were extracted from an application case performed within a real automotive plant, which demonstrated the feasibility of this research towards a more proactive management approach.

Classification of Reconfiguration Resources and Lead Time for Reconfigurable Manufacturing Systems (248)

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Manufacturing technology can improve the turnover of a company if it enables fast market introduction for volume production. Reconfigurable equipment is developed to meet the growing demand for more agile production. Modular reconfiguration, defined as changing the structure of the machine, enables larger variation of products on a single manufacturing system; these solutions are called Reconfigurable Manufacturing Systems (RMS). The quality of RMS, and the required resources to bring it to reliable production, is largely determined by a swift execution of the reconfiguration process. This paper proposes a method to compare alternatives for the ways to implement reconfiguration. Three classes of reconfiguration are defined to distinguish the impact of the proposed alternatives. The procedure uses a recently introduced index method for development of RMS process modules. This index method is based on the Axiomatic Design theory. Weighing factors are used to calculate the resources and lead time needed to implement the reconfiguration process. Application of the method leads to quick comparison of alternatives in the early stage of development. Successful execution of the method was demonstrated for the manufacturing process of a 3D measuring probe.

Modeling, Simulation and Decision Support Systems

A Bayesian Network Based Decision Support System (43)

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In this highly dynamic environment, data and information are rapidly changing in time. For a decision support system, to capture continuum data and then to extract knowledge from data is in high demand. Our research work focus on developing a systematic approach for discovering causal relations among data and dynamic updating upon to the varying goals. Bayesian network is a powerful tool for representing knowledge and tackling the above inquires. In this research, the entropy-based searching mechanism designed on Bayesian network is adopted to learn the structure of a goal-specific mission. Link strength and connection strength are the measures for selecting links to be added and subtracted. However, these two measures are the relative measures instead of absolute thresholds. Initially, we designed a link/connection strength selecting method for possible adjacency matrices in tabu searching. In the second phase, we used a homogeneity test to ensure the quality of the learned structure. The results of this study will be an important stepping stone to attain the learning requirements of designing, building, and operating effective decision support systems under dynamic environment.

Hardware in the Loop Simulation-Based Training for Automated Manufacturing Systems Operators (66)

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Simulation-Based-Training (SBT) allows to train the operators of complex machinery within a safe virtual environment by means of effective lifelike learning experiences. SBT has been efficiently used in medical, aerospace and military fields and it may provide a competitive advantage also for the training of operators in mechatronic plants. In fact, at the current state of the art, human-machine interaction still heavily impacts on the final performances of automated plants. Since the fast-evolving process dynamics of the machinery is controlled and supervised by complex software logics, the main challenge for effective and valid SBT concerns the development of a real-time simulation, where the control system responsiveness is fully reproduced. This paper deals with a novel SBT workbench used for steel plants operator training, discussing the real-time simulation architecture developed for the purpose. Following a hybrid process simulation approach, real-time control Hardware-In-the-Loop technology assures seamless and accurate reproduction of the real plant, also achieving the desired Man-in-the-Loop practice for the operator interaction. A conceptual architecture for a virtual interactive prototype is proposed, including controllers and interfaces for trainer and trainees. A case study on an electric arc furnace is implemented within a Virtual Commissioning tool, analyzing its capabilities and limitations.

An Integrated Web-based Scheduling and Quality Decision Support System (SQDSS) (72)

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Decision Support Systems (DSS) have evolved from being considered as a competitive edge to a survival strategy. In different echelons of a value chain, when DSS is combined with lean tools it drives out not only the non-value added activities (muda a.k.a. waste) from the process but also provides a decision making tool at the hands of the people. In this paper, a successful implementation of a Scheduling and Quality Decision Support System (SQDSS) at a service sector, a direct mail (letter shop) company is explained. The two primary benefits garnered were (1) attainment of 100% scheduled delivery date adherence with less rework, and (2) a seamless communication platform across the value chain to see quality defects, plan the work, and to make the product flow efficiently across the value stream. The unique contribution of this work is the original implementation of a web based decision support system that was the backbone of reducing the complexity of scheduling and improving the quality of service delivery in a high variety and low volume letter shop environment.

On a Paired-t Confidence Interval Based Ranking and Selection Method (78)

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Simulation optimization is a widely used methodology for complex stochastic system design. Though the simulation provides a flexible tool for model building, the optimization process could be very challenging due to the cumbersome computing times. A paired-t confidence interval based ranking and selection method is developed to tackle such a problem. The survive probability of each candidate system is calculated with the lower and upper bounds of the confidence interval obtained using paired-t comparison method. The proposed method is tested with several numerical examples. The experimental results suggest that the proposed method outperforms the other classical Ranking and Selection procedures.

Chances of the Application of Multi-Domain Simulation Tools in the Field of Train System Engineering (79)

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Complex mechatronic systems, such as modern trains, demand interdisciplinary software tools in order to test systems as a whole and predict operational behavior. Caused by the intention of cost savings and pushing the market launch time, computer-aided modelling and simulating of the behavior of single devices, such as thermal effects, stresses, deformations and also electrical state variables, have long since become state-of-the-art. This method leads to well-matured products. The component integration into the system as a whole, however, often causes trouble due to the lack of computer and software assistance. Furthermore, the diverse engineering fields do not have the expertise to collaborate. Therefore, joined system testing and improving is difficult and uncommon. Since the different mechanical and electrical components are being developed and tested independently, overall system behavior can hardly be forecast. As a consequence, during the system assembly phase, unpredicted in-compatibilities and system malfunctions can appear. In order to integrate the train subsystems into an overall system and allow for a better synchronization and proper system testing, the application of multi-domain model-ling and simulating is recommended. In this regard, the benefits brought by multi-domain applications will be discussed in this publication, using the example of a modern train. Thereafter, a case study of a pneumatic train brake application follows. Its results are exemplarily being shown to demonstrate future perspectives. Models and simulation results of the brake and air supply components already turn out allowing for comparisons with the actual system. System start-up times of the simulation match actually measured times adequately.

Harmonized Decision Modeling Process for Smart Grid Component Allocation (98)

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This article presents a harmonized decision modeling framework for smart grid component allocation. The harmonized decision modeling process is intended to realize a decision support system for the smart grid system analysis. The traditional decision modeling processes have mainly stresses the economic feasibility of smart grid systems. However, the mathematical programming-based decision models for component allocation in smart grid systems are often designed without the enough consideration on the operational circumstances of component, and it reduces the utility of the solution. Our framework considers the operational circumstances of the system and the feasibility in terms of solving process for achieving a practical decision. As a case study, we present a component allocation of Phasor Measurement Units (PMUs) in smart grid systems. With the obtained results, the advantages gained from the harmonized decision modeling process are assessed and discussed.

A Constructive Cooperative Coevolutionary Algorithm Applied to Press Line Optimisation (100)

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Simulation-based optimization often considers computationally expensive problems. Successfully optimizing such large scale and complex problems within a practical timeframe is a challenging task. Optimization techniques fulfilling this need are to be developed. A technique to address this involves decomposing the problem into smaller subproblems. These subproblems are then optimized separately. In this paper, an efficient algorithm for simulation-based optimization is proposed. The proposed algorithm extends the cooperative coevolutionary algorithm, which optimizes subproblems separately. To optimize the subproblems, the proposed algorithm enables using a deterministic algorithm, next to stochastic genetic algorithms, getting the flexibility of using either type. It also includes a constructive heuristic that creates good initial feasible solutions to reduce the number of fitness calculations. The extension enables solving complex, computationally expensive problems efficiently. The proposed algorithm has been applied on automated sheet metal press lines from the automotive industry. This is a highly complex optimization problem due to its non-linearity and high dimensionality. The optimization problem is to find control parameters that maximizes the line's production rate. These control parameters determine velocities, time constants, and cam values for critical interactions between components. A simulation model is used for the fitness calculation during the optimization. The results show that the proposed algorithm manages to solve the press line optimization problem efficiently. This is a step forward in press line optimization since this is to the authors' knowledge the first time a press line has been optimized efficiently in this way.

Simulation Metamodelling of Chosen Production System (122)

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The authors deal with simulation metamodelling as a progressive approach of simulation optimisation of manufacturing and logistics processes. Describing the input-output relationships of an analysed process one can easily find out system responses when changing the values of selected input factors, and predict the future behaviour of the chosen system parameters. This allows to quickly try different troubleshooting variants and to minimize the risk of wrong decisions, what will be reflected in the considerable economic benefits. This is known as an approximated production management. There are many mathematical formulas to express the relations between variables. Therefore, the authors of the paper devoted only a few of them. Further they describe a generic procedure for metamodel construction, the approach for auto-generation of an appropriate metamodel and they demonstrate the whole method on a simple production system.

Resolving Waiting Time Issue in Healthcare: A Simulation Modelling Approach (176)

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Healthcare Services across the globe are going through a very challenging phase under the current economic uncertainty. Among many other public services which are under the financial scrutiny healthcare services is the most affected one. This is primarily attributed to severe funding cuts and reduced headcounts that have resulted in long waiting queues for a variety of medical treatments. The delay in treatments due to the lack of resources have caused huge outcry among the general public. Therefore, healthcare services are under immense pressure to reduce their inefficiencies and improve their operational performance. Inspired by the on-going challenges faced by the healthcare service organizations, this research aims to study the role of discrete-event simulation modelling tool in reducing the waiting time issues. This research investigates waiting time issue faced by the physiotherapy department of an Irish hospital. The data for the simulation study was collected through personal visits to the physiotherapy department. As a first step towards the simulation modelling, a process map of the department was constructed. Thereafter, simulation model was developed and tested for alternative scenarios to tackle the waiting time problem. The result shows that simulation modelling can be a very effective tool in resolving the waiting time issue by providing managerial decision makers vital information on how to use their resources efficiently.

Using Adaptive Neuro-Fuzzy Inference Systems to Monitor Non-Linear Quality Profiles (239)

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In common Statistical Process Control (SPC) applications one or multiple quality characteristics with corresponding univariate or multivariate statistical distributions are employed to represent process or product quality. However, there are several other practical situations, in which the quality of the process or product can be more effectively characterized and summarized by the relationship between the quality characteristic as the response variable and one or more explanatory variables. These problems are studied under the framework of quality profiles. In some applications, the profile relation can be adequately represented by a linear model, while in other applications non-linear models are needed. In this paper, using Adaptive Neuro-Fuzzy Inference Systems (ANFIS), we propose a novel approach for both modelling and controlling non-linear quality profiles. We also conduct extensive simulation studies to compare the proposed approach with traditional methods.

Product Development, DFM&A, and Materials

Evaluation Framework for Crowdsourced Design Concept Management (28)

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Crowdsourced design concepts are reported to be more creative than internal ideas and the cost of idea sourcing from the crowds is less expensive than from the conventional sources. However, the crowdsourced design has not been well utilized especially for complex engineering systems. One of the reasons is that the crowdsourced data, information, and knowledge are not well managed and evaluated to generate the expected quality and feasibility. The aim of this paper is to present an evaluation framework for crowdsourced design concept management and to couple ideas and solutions with the purposes or objectives of new product development, more efficiently. In the paper, features and characteristics of crowdsourcing new product development are discussed, and formal measures are proposed. An illustrative example is presented to describe how the evaluation framework can be used in crowdsourcing design.

Creating a Flexible Data Management Environment in CAD/CAE/CAM for Product Lifecycle Management (30)

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Most commercial CAD/CAE/CAM software programs offer Product Data Management and Product Lifecycle Management functionality that incorporates 3D design/graphics, engineering drawings, digital archiving and revision control, collaboration tools and centralized databases for managing information and facilitating reduced times to market. Although these systems are powerful and available for product designers, engineers and managers, over-stated capability and cumbersome user interfaces often fail to deliver on promises made to customers. In addition, the resources for implementing these programs and the high cost of software licenses have forced many companies (especially small-medium sized) to post-pone or reconsider plans to invest in this promising technology. This paper describes a methodology for streamlining the engineering and development of new products using computer aided applications and software made using Application Programming Interface tools. Advances in computing and engineering will bring new ideas and innovation to make the product development process more agile and customizable to the needs of each company. This paper focuses on combining the areas of CA'X' based product development and software engineering to address some of the shortcomings of "off the shelf" programs and raise awareness of the possibilities that exist when CAD/CAE/CAM is viewed as the hub of a more integrated and flexible working environment that is rich with accessible information.

Value Stream Mapping along the Product Development Process (46)

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Today's business conditions are characterized by increased competition. Therefore enterprises have to cope with shorter product life cycles, higher product complexity and more product variants. The reaction of many enterprises is to launch new products in shorter intervals. This confronts companies with the challenge to pass through the product development process faster. The product development processes need to be parallelized and waste within the processes needs to be identified. In the past, methods of Lean Production Systems have been successfully used to identify waste in production and product development processes. Lean offers an established approach to eliminate waste and increase customer value in all processes. Especially the value stream mapping method is used to identify waste in processes and to concentrate on value creation. To improve the entire product development process from development to start of production, this process has to be mapped and analyzed. Therefore, this article analyzes different value stream mapping methods regarding the specific requirements of the product development process. In the following, an approach is presented which has been tested in an enterprise in order to improve the product development process.

Considering assembly requirement specifications in product development: Identification and Approach (62)

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Due to the major advantages such as reduced time to market and improved quality at lowered cost, the principles of design for assembly capabilities and concurrent engineering are of great significance when developing new products. However, identifying assembly requirement specifications and considering them in New Product Development (NPD) in a timely manner, while securing efficiency and robustness of assembly processes, still remains a challenging task. In presenting a case study of an NPD project in a manufacturing company, this article focuses on the process of capturing and incorporating the requirements related to the assembly system during the early phases of NPD. Further, the results of the research study indicate the different assembly requirements in the case company and pinpoint the challenges in practices involved in handling them. The assembly requirements identified in this research reflect some of the challenges encountered in handling the requirements, through the investigated requirement practice. Based on the results, the issues of when and how to consider the assembly requirements are highlighted in the conclusions and suggestions for future research are made.

3-D Biocompatible Microneedle Arrays with Nanoporous Surface (74)

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During the past few years, developing painless needles or patches to replace traditional hypodermic needles has been investigated. Since micromachining can be used to construct a high density metallic micropillar array, we propose to use a biocompatible metal oxide, such as Al2O3 and TiO2, as an alternative material for fabricating arrays of microneedles. In this study, we fabricated an anodic aluminum oxide (AAO) covered Al micro-indent array using electrochemical and mechanical micromachining. We demonstrate use of a nanoindenter to make pyramidal indentions on Al surface in order to produce a female microneedle array mold. We also performed melting injection to fill AAO template with ultra-high molecular weight polyethylene (UHMWPE) to produce UHMWPE nanotubes. The microneedle array provides a 3-D structure that possesses several hundred times more surface area than a traditional nanotube template. This suggests that a medical-grade polymer microneedle array can potentially be formed for more applications. This 3-D microneedle array device can be used not only for painless injection or extraction, but also for storage, highly sensitive detection, drug delivery, and microelectrodes.

Optimizing the Morphing Displacement of Sandwiched Nanotube Buckypaper Actuators via Design of Experiments Methodology (120)

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The actuation properties of carbon nanotube buckypaper have been proved and demonstrated in many researchers' studies. Sandwiched buckypaper/porous film+ion liquid/buckypaper structure showed the lightweight and high efficient morphing displacement actuator at a low electrical power with square wave frequency. However, the buckypaper actuation performance showed the huge variation due to their material components and manufacturing process. Buckypapers are made by different type's carbon nanotubes and fabricated by difference preparation processes will result in various electrical properties and actuation performance. This work first explores the paper's electrical properties fabricated by two manufacturing process of positive pressure filtration process and negative pressure filtration process. Additionally, we will compare and optimize the displacement performances of two different buckypapers, analyze the relationship between the electrical properties and displacement and blocking force performance buckypaper actuator via Design of Experiment (DOE) methodology. It is important to understand their material property-actuation performance relationships in order to model and predict the behavior of these actuators. The electromechanical actuation of macroscopic buckypaper structures and their actuators will be investigated and analyzed. Using DOE methodology, the optimal or appropriated manufacturing parameter settings will be suggested for high displacement, stable actuation, and good durability within fewer experimental runs.

Optimum Constant-stress and Step-stress Accelerated Life Tests under Time and Cost Considerations (185)

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By running life tests at higher stress levels than normal operating conditions, accelerated life testing quickly yields information on the lifetime distribution of a test unit. The lifetime at the design stress is then estimated through extrapolation using a regression model. To conduct an accelerated life test efficiently with constrained resources in practice, several decision variables such as the allocation proportions and stress durations should be determined carefully at the design stage. These decision variables affect not only the experimental cost but also the estimate precision of the lifetime parameters of interest. In this work, under the constraint that the total experimental cost does not exceed a pre-specified budget, the optimal decision variables are determined based on C/D/A-optimality criteria. In particular, the constant-stress and step-stress accelerated life tests are considered with the exponential failure data under time constraint as well. We illustrate the proposed methods using a case study, and under a given budget constraint, the efficiencies of these two stress loading schemes are compared in terms of the ratio of optimal objective functions based on the information matrix.

Sustainable Design and Innovation for Office Furniture and its Implementation (260)

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Products such as furniture are a combination of components that together provide the functionality required by the customer. For the designer, the product configuration has special importance. The impetus for new ideas becomes obvious as they will influence the future industrial designers. The objective of this research is to develop a new tools to help designer make a most effective decision making toward sustainable design. At early design decision makings, the design concept selection at the component design level can cause the product to be redesigned or remanufactured. Early design decision makings are essential and have significant impact on sustainable design of furniture products. However, there are still challenges to evaluate a significant sustainable design especially to furniture industry on open plan system. The aim of the research presented in this paper is to address the issues above in an integrated sustainable design.

Production Planning and Scheduling

A New Solution Representation for Developing Meta-heuristic Algorithms to Solve Distributed Flexible Job-Shop Scheduling Problems (3)

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This paper addresses a scheduling problem, called distributed and flexible job shop scheduling (DFJS) problem. The DFJS problems have been solved in literature by using meta-heuristic algorithms based on various solution representations. This paper proposes a new solution representation (called Snew) and develops two new meta-heuristic algorithms (respectively called GA_Snew and ACO_Snew). The two proposed algorithms both outperform prior meta-heuristic algorithms on solving the DFJS scheduling problems.

Using Simulation to Determine the Batch Size for I/O Drawer Test Process in a High-End Server Manufacturing Environment (19)

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In this research, discrete-event simulation is used to study the I/O drawer test process in a high-end server manufacturing environment in order to identify the optimal batch size of the I/O drawers to be tested per driver. High-end server manufacturing environment is characterized by fast lead time and lengthy build process. Therefore, main components of the server, such as I/O drawers, are tested ahead of time (fabrication test) and stored in inventory as tested parts to be ready for prompt fulfilment of the customer orders. In this research, a simulation model is developed for the I/O drawer test process with a focus on batching the I/O drawers on testing. Different scenarios for the batch size are considered and a statistical comparison is performed against the current scenario used by the I/O drawer Fab test operators. Unlike the "one-piece flow" lean concept which encourages small batch size (even one), the results show significant savings in cycle time and energy consumption when the batch size is increased. This is attributed to the lengthy setup time of the I/O drawer testing process as using small batch sizes requires very short set-up time. The optimal batch size scenario results in cycle time savings by 20% which is equivalent to 8116 hours per year. Other savings include: electrical energy and less consumption of chilled water for the cooling units.

From Machine Utilisation to Flow time: Effects of Lean Transformation on Scheduling (53)

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The Lean paradigm transforms a production company from utilisation-centric planning into a system in which other operating conditions such as short flow times, local control, and reduction in variation are weighted as well. This paper studies how the scheduling of production changes when the above three conditions are implemented. Their effects are studied by constructing an optimisation model for the scheduling of a flow shop. The optimisation model is based on the following ideas. First, when the flow time is emphasised, the objective of the scheduling changes from utilisation to a short flow time. Second, if local control is used, it means that the optimisation is done locally, i.e. individually at each station, and it concerns the makespan at the station. Third, if the variation is reduced, the processing times and arrival times have less variation and the scheduling can force the flow times to have less variation by using first-in-first-out (FIFO) sequencing. The experimental results achieved using the model describe how and in which order the operating conditions under study should be implemented in the scheduling. For example, if utilisation is important, local control and FIFO should not be used before variation is reduced.

Batch Size Optimization based on Production Part Cost (105)

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When investigating different location and/or system designs the possible variables to take into consideration can differs between the alternatives. Different production system will have different optimal working conditions and hence should be compared with parameters suitable for the actual production system. When planning production and calculating production costs the batch size is of high interest. Based on a manufacturing part cost model, this paper will present a new model, close connected to the production system, integrating production performance, set-up times, material costs, material handling costs and tied capital, giving the production economic optimal batch size. The aim is to give companies a model for determining the economic optimal batch size in order to use this knowledge to make strategic decisions regarding production planning. Mathematical simulations are performed to analyse the differences in result from the developed model and Wilsons existing standard method for calculating the economic order quantity, hence to verify the importance of making an in-depth analysis, taking the production system into consideration. The advantage of the developed model is the usage of production costs based on variable batch sizes, giving a more accurate outcome.

Minimization of Transportation and Installation Time for Offshore Wind Turbines (174)

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The most challenging aspect of introducing an offshore wind energy facility is high cost of capital for transportation and installation of wind turbines. The cost associated with transportation and installation depends on the required time to complete these processes and the time requirement can be minimized by optimum selection of many variables of transportation and installation operations such as onshore pre-assembly of turbines, rated power output of each turbine and number of turbines in the wind farm. Impact of these decision variables on total time requirement of transportation and installation is investigated in this paper, and a time estimation model for wind turbine installation and transportation is developed. Effect of wind farm and vessel parameters on time requirement is studied. Also a numerical study is performed to illustrate the model. The results show that total time requirement is significantly impacted by turbine size and pre-assembly method.

Concept of Semi-Autonomous Production Planning and Decision Support Based on Virtual Technology (193)

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The following conceptual contribution is based on the two scientific fields Digital Factory (DF) as well as end-user electronics. The two fields which describe the starting points for the conceptional contribution offer promissing potential for the future production and planning process. At first it can be stated that the DF is an established umbrella in industry. However, many enterprises are not capable to reap the full potential of the DF. Major obstacles are the efforts for creating digital models, updating models due to adjustments of real-world systems and employing digital models for operational planning like production planning and control. Hence, there is a clear gap between real-world production systems and their digital counterparts, which should be filled by synchronizing both worlds in reasonable – or even real – time. A further observation provides the second starting point: Latest end-user electronics made for everyday life provide powerful computing and visualization power as well as intuitive design at reasonable cost. Hence, virtual technologies (i.e. Augmented- and Virtual Reality) are not restricted to a small group of specialists anymore. The consequent question is how such rapid developments fit or can be fitted into the harsh industrial context. We propose that shop floor employees use virtual technologies to interact between synchronized worlds and software agents offer aggregated information to users. Utilizing software agents leads ultimately to semi-automatic planning processes where agents run simulations autonomously and propose planning scenarios.

Factors for a Decentralized Production and Sequence Planning from the Perspective of Products and Resources (209)

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The trend towards more and more individual products leads to new challenges for production planning and scheduling. Rising numbers of variants, high fluctuations of demand and smaller production volumes require flexibility in production, which fixed assignments of products to lines often can't provide. A network of numerous internal and external manufacturing resources is necessary. The centralized production planning methods, used today, have reached the limit of their abilities in finding the best manufacturing route through this complex networks for each product. Approaches like industry 4.0 and smart manufacturing are current responses to handle mass customization by decentralization and enhanced computerization. In the future products will communicate with the machines as autonomous entities and find their optimal route through production on their own (managed by multi-agent systems). To reach this degree of self-control, systems need implemented criteria as basis for decision-making. This paper considers the different objectives of a product as it flows through the production (punctual delivery to low costs) on the one hand and, separately on the second hand, which factors the machines or resources need to optimize their schedules and what their goals are (high utilization and low costs). The different perspectives between the product objectives and the resources objectives are vividly illustrated in the analogy of a traveler planning his tour and a railroad company planning it´s time tables. This paper provides the important factors of influence and thereby supports the formation of a target system for software agents. It shows how product agents can decide which route to take through production and how resource agents find the optimal production program.

Development of Predictive Production Model for Increasing Productivity of Oil Wells (210)

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This paper highlights some of the reasons for the oil production decline in petroleum wells and underlies principles to produce a new model for the oil wells' production performance. The research starts by introducing some information about the available world energy resources which shows that petroleum and natural gas are used more than any other energy sources. The research also presents further information about the productivity index of oil producing wells and their performance including how this is affected and how it can be enhanced using different available methods. The total world oil reserves, gap in production and demand and how this research is important for increasing the oil production is explained. The analysis shows that a 15.47% increase in the oil reserves between the years 2008 and 2012 had caused the total world oil reserves to increase from 1,280,114 million barrels in 2008 to reach 1,478,211 million barrels in 2012. The research has showed that the additional 198,097 million barrels are sufficient to cover the world's demand for oil for about six years based on the rate of oil demand in 2012 of 32,459 million barrels. However, the total world's oil production in 2012 is 26,611 million barrels which is not enough to meet the demand. Therefore, the aim of this research is to find suitable methods for producing oil from the available oil reserves to cover the demand by reducing the losses in the oil producing wells rather than depleting the newly found reserves. However, this research is still ongoing and it is expected to give more interesting and valuable results in the future.

Quality Control, TQM, Process Improvement, Operations Management and Productivity

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An Investigation into the Challenges of Implementing the EFQM Excellence Model (9)

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In recent times there has been an increasing trend, among organisations, towards the adoption of business excellence models (i.e. EFQM, Malcolm Baldrige, and Deming) as a strategic approach to drive improvements. This research takes a divergent-empirical perspective from the narrow view of current studies by investigating the challenges that organisations face when implementing the EFQM model. Semi-structured qualitative interviews were conducted with a group of five EFQM experts that comprised quality management consultants and business managers. Primary data from participants was analysed using the qualitative content analysis approach, to collect, organise and extract key contents from the interview data. The results of the study suggest that, like with most TQM initiatives, the challenges that organisations face when implementing the EFQM model include factors such as: lack of viable leadership and top management support, lack of adequate planning, lack of skills, resources intensity, closed vertical communication, focus on short-term objectives (quick results), lack of employee commitment, and organisational structure, size and sector. The results of this empirical study can help managers and business excellence professionals understand the barriers and challenges that can impede the effective implementation of the EFQM model. It is only by understanding these challenges that best practises can be developed in order to mitigate them.

Process Variability Reduction by Using the Design of Experiment – A Case Study (17)

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Low process variability and capability index might be some of customer's requirements. Therefore it is necessary to fulfil these requirements and guarantee them in the future. Since state-of-art companies that want to keep up with competitors have to consider all actions which might prevent losses or customer's dissatisfaction. This paper deals with possibilities how to decrease the process variability and satisfy customers. For process variability decrease, statistical experiments were carried out. The paper contains a case study devoted to the usage of design of experiment (DOE) in the production process. The case study reveals ways of dealing with real production problems and offers an effective treatment.

Analysis of Internet Process Tool for Continuous Improvement and Productivity in a Manufacturing Environment (31)

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In today's busy, highly competitive market, businesses are under increasing pressure to meet targets and achieve their objectives. Previous research has shown that SMEs not only need to satisfy customer requirements, but must also meet shareholders' demands for returns on their investments. There is a wealth of research publications available to SMEs especially on the use of continuous improvement techniques; however, SMEs do not always make use of these facilities. This research focuses on analysis of a web-based process tool to quantify improvements that can be used as an incentive to gain management commitment and to support other SMEs within a community of practice in order to implement improvements in a manufacturing environment. Using Action Research in an SME environment inefficiencies have been identified and classified. The Internet portal will provide user-friendly access to Continuous Improvement CI tools suitable for SMEs within a community of practice and will contain simple to use CI tools which will enhance business productivity. The overall objective is to motivate SMEs within a community of practice to adopt process improvement techniques, especially those generated by academic research, and thereby minimise waste in the business environment.

E-quality Control in Automotive Manufacturing – An Integrated Approach Using 3D Measurement and Photometric Stereo Reconstruction (87)

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Intense pressures for quality control are experienced by automotive parts suppliers to stay tuned in competitiveness and to build a long-term relationship with automotive manufacturers. The automotive parts suppliers are urged to contribute towards enhancing the overall quality of national car. E-quality is a process through which inspection of the process and quality of the part produced is done online resulting in the improvement of the process and reduction in the amount of time consumed for the overall process. Automated quality control involves using a methodology to classify the parts based on the damages or the dimensions of the features on a part. However, achieving high classification accuracy is not an easy task, especially in area of quality control where small differences in damages or dimensions result in part fall into a different category. And also the traditional 2D vision is not as reliable as 3D measurement due to the limitations of the technology and the structure of a part. In this study, a novel approach which integrates photometric stereo reconstruction and 3D measurement for 3D inspection is presented. The data extracted from brake caliper and lever brake was used as case study to demonstrate the proposed methodology. Results show that the new methodology yielded superior

results compared to the traditional inspection approach with very high classification accuracy. Moreover, the proposed approach is capable to archive 3D models of the parts and achieve rapid quality control. This paper forms the basis for solving many other similar problems that occur in many industries.

An Empirical Study of TQM and its Effect on the Organizational Sustainability Development: A Successful Model for Implementation (199)

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The main purpose of this research is to construct a generic model for successful implementation of Total Quality Management (TQM) in Oil sector, and to find out the effects of this model on the organizational sustainability development performance (OSDP) of Libyan oil and gas companies using the structured equation modeling (SEM) approach. To achieve this aim, both quantitative and qualitative research methods are adopted. Based on the literature search, a questionnaire was developed to identify the quality factors that are seen by Libyan oil and gas companies to be critical to the success of TQM implementation. 93.33% questionnaires were returned. Hypotheses were developed to evaluate the impact of TQM implementation on OSDP. The empirical analysis demonstrates several key findings: data analysis reveals that there is a significant positive effect of the TQM implementation on OSDP. The analysis indicated that 24 quality factors are found to be critical and absolutely essential for successful TQM implementation. Semi-structured interviews were also conducted to discover how these CQFs are experientially rated in specific organizational contexts. An in-depth case study analysis of two selected organizations provided understanding of the process of successful TQM implementation. The results generated a structure of the TQM implementation framework linked to OSDP based on the four major road map constructs. Libyan oil companies should consider TQM as an innovative tool for improving OSDP in today's dynamic industry environment.The findings suggest the notion that the TQM critical success factors (CSFs) should be implemented holistically rather than on a piecemeal basis to get the full potential of the TQM.

Quality Measurement in the Supply Chain (242)

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Supply Chain Management is the integration of business processes along the value chain, from suppliers to end customer. Performance measurement of these processes has so far received little attention from researchers and practitioners. This paper reports the results from a study of a discrete products supply chain and measures its performance. In particular, a case study was conducted on a wood product supply chain, with a focus on quality performance measurements. The research question was whether current practices were consistent with end customer satisfaction and if improvements were possible. Interviews with quality management personnel and on-site evaluations were conducted at all stages of the supply chain, and a new visualization tool was developed. Quantitative and qualitative analysis tools were used to evaluate current practices. Opportunities for improvement were found in external integration and information sharing between supply chain partners. Also, a need for true measures of supply chain performance measures was identified. A 5-step process to develop such metrics is proposed, and an application example is provided. The proposed supply chain performance measurement system uses Six Sigma measures and facilitates collaboration between supply chain partners and provides information that allows focusing on improvement projects more efficiently.

Designing a Fuzzy Control System for Non-Random Pattern Detection in Individual Observation Control Charts (255)

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Control charts are considered as one of the most powerful tools for process monitoring and improvement. The main objective of control charts is to monitor quality characteristic and to detect assignable causes. Traditional control charts have a good performance in detecting step changes but they aren't sensitive in detecting other non-random patterns. Therefore, various statistical and soft computing techniques have been used extensively to recognize non-random patterns. In this paper, using fuzzy logic and statistical concepts, a fuzzy control system is designed to recognize non-random patterns of individual observation control charts. For this purpose we simply use the p-value of non-random patterns statistical tests for determining the membership functions of the fuzzy system. We also compare the performance of the proposed system to other fuzzy control systems which have been developed for this purpose and demonstrate the efficiency of the proposed system.

Requirements for Manufacturing Operations Management and Control Systems in a Dynamic Environment (48)

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In today's highly dynamic manufacturing environment smooth information flow between planning and shop floor level is essential to ensure rapid reaction to changes. Unfortunately, the currently utilized dispersed MS Excel applications for production scheduling and control don't provide such an information flow. The transparency between different operational levels, and therefore the big picture, is lacking. To illustrate these challenges, this paper presents the first results of interviews, conducted among Finnish machine building companies, relating to the current practices and challenges as well as future requirements for manufacturing operations management and control systems.

Research on Life-cycle Process Management of Petroleum Geophysical Exploration Engineering Project in China (235)

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In recent years, project management has been gradually implemented within China's petroleum geophysical exploration and development engineering. Recently, achievements have been made in the institutionalization, routinization and standardization of project management in petroleum industry. The sustainable development of petroleum enterprises has been ensured by process management, which based on the entire life-cycle of geophysical exploration project. In this paper, the relations between project life-cycle and project management process have been elaborated. Furthermore, the process management based on the entire life-cycle of geophysical exploration project has been established. The author believes that process management would be beneficial to the overall efficiency of petroleum geophysical exploration.

Equipment Maintenance and Effectiveness

Practical Evaluation Workover Framework (PEWF) for Evaluation and Process Improvement of Workover Rigs in the Oilfields (112)

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In this work Practical Evaluation Workover Framework (PEWF) can be defined as a procedure that provides a practical workover maintenance system for workover and production engineers in the Oilfields. This procedure involves operators and technicians in the workover rigs acting as a team to monitor the workover procedures including Electrical Submersible Pump (ESP) processes (installation and nu-installation) and reduce the production losses in the oil wells by returning the oil well to production in the right time. The model's detail and procedures are simple to use and it supports workover rigs to implement the main structures of Total productive maintenance (TPM) to improve the efficiency of the workover rig. PEWF is built on the collection and analysis of the Overall equipment effectiveness (OEE) data gathered by the workover and production engineers on the workover rig. The OEE monitors the actual performance of workover relative to its performance capabilities under optimal workover conditions. The main purpose of an OEE results is to present essential data against where decisions may be made. These measurements assist the management to evaluate progress and help production and workover engineers identify the sources of problems on ESP processes and workover rigs activities. This method of calculating rig efficiency provides the practical measure of the workover performance which can aid in rig procedures negotiation and workover rig selection.

Improving Maintenance Processes with Socio – Cyber-Physical Systems (104)

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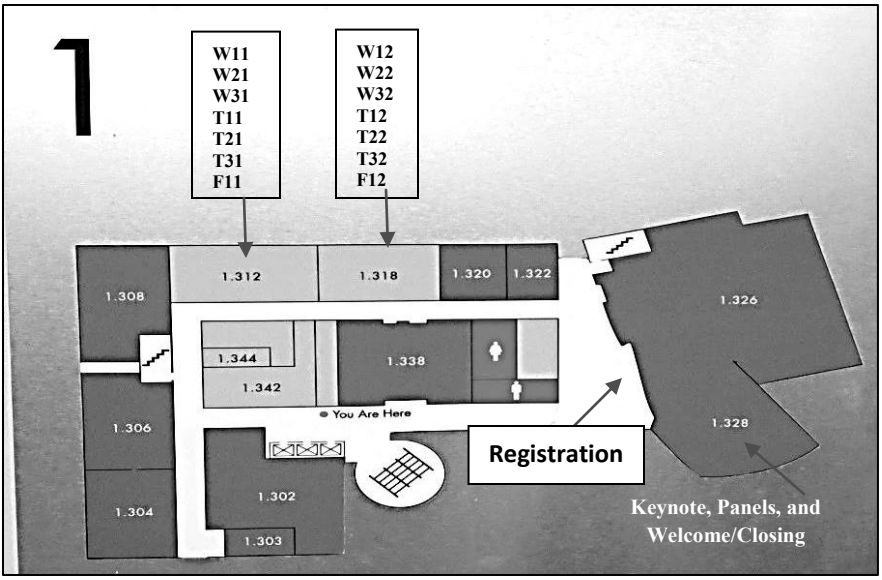
Maintenance is an important factor for the effectiveness of production processes. With the help of new information and communication technologies, the maintenance processes are supported and optimized. Cyber-physical systems link physical objects with information equipment. Objects such as machines, parts or tools carry sensors, control and communication devices to enhance their capabilities. In that way, they become smart and act as active participants in intelligent information networks. Furthermore, they communicate directly with humans. Thus, social factors (e.g. usability of devices, competencies or responsibilities of users) have to be involved in the design of information flows. However, different information systems are used in a factory. The data flows of different areas such as production planning and scheduling, staff planning, material management and machine monitoring often run in parallel and the maintenance is often just involved marginally in the digital systems. For that reason, a resource cockpit will be developed in the research project "Socio – Cyber-Physical Systems" (S-CPS). The cockpit will bundle and provide relevant data and information about products and production resources for maintenance processes, especially under consideration of social impacts. In the paper, the potentials of socio-cyber-physical systems for maintenance and objectives and activities of the research project are presented.



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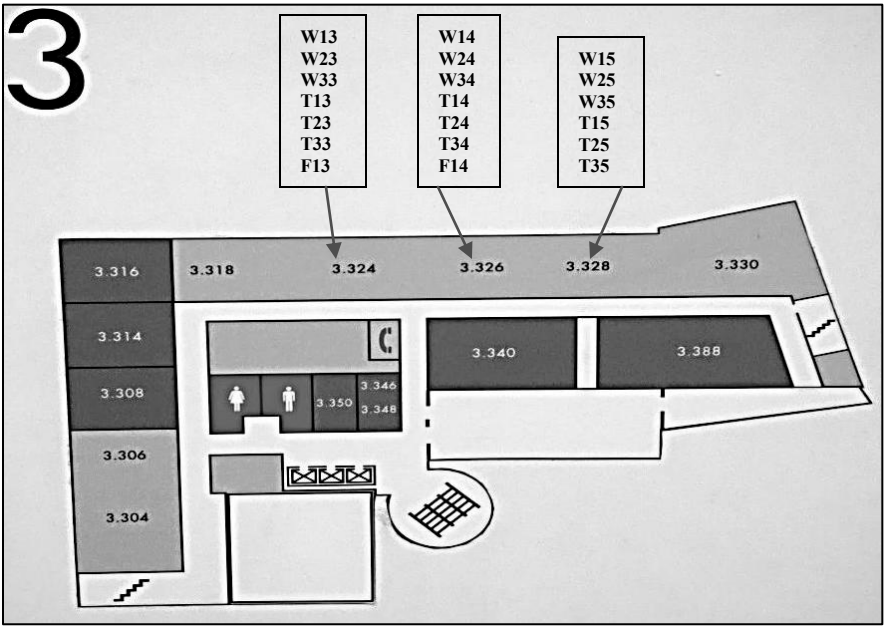

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