

*Proceedings of the ASME*

**INTERNATIONAL DESIGN ENGINEERING TECHNICAL  
CONFERENCES & COMPUTERS AND INFORMATION IN  
ENGINEERING CONFERENCE**  
**- 2019 -**

---

**VOLUME 1**  
**39TH COMPUTERS AND INFORMATION IN  
ENGINEERING CONFERENCE**

presented at  
ASME 2019 INTERNATIONAL DESIGN ENGINEERING TECHNICAL CONFERENCES &  
COMPUTERS AND INFORMATION IN ENGINEERING CONFERENCE

AUGUST 18-21, 2019

ANAHEIM, CALIFORNIA, USA

sponsored by  
DESIGN ENGINEERING DIVISION, ASME  
COMUTERS AND INFORMATION IN ENGINEERING DIVISION, AMSE

**THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS**  
**Two Park Avenue \* New York, NY. 10016**

Printed from e-media with permission by:

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



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

Statement from By-Laws: The Society shall not be responsible for statements or opinions Advanced in papers...or printed in its publications (7.1.3)

INFORMATION CONTAINED IN THIS WORK HAS BEEN OBTAINED BY ASME FROM SOURCES BELIEVED TO BE RELIABLE. HOWEVER, NEITHER ASME NOR ITS AUTHORS OR EDITORS GUARANTEE THE ACCURACY OR COMPLETENESS OF ANY INFORMATION PUBLISHED IN THIS WORK. NEITHER ASME NOR ITS AUTHORS AND EDITORS SHALL BE RESPONSIBLE FOR ANY ERRORS, OMISSIONS, OR DAMAGES ARISING OUT OF THE USE OF THIS INFORMATION. THE WORK IS PUBLISHED WITH THE UNDERSTANDING THAT ASME AND ITS AUTHORS AND EDITORS ARE SUPPLYING INFORMATION BUT ARE NOT ATTEMPTING TO RENDER ENGINEERING OR OTHER PROFESSIONAL SERVICES. IF SUCH ENGINEERING OR PROFESSIONAL SERVICES ARE REQUIRED, THE ASSISTANCE OF AN APPROPRIATE PROFESSIONAL SHOULD BE SOUGHT.

For authorization to photocopy material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act, contact the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923, Tel: 978-750-8400

Requests for special permission or bulk reproduction should be addressed to [permissions@asme.org](mailto:permissions@asme.org).

**ISBN NO. 978-0-7918-5917-9**

**© 2019 ASME  
All rights reserved.**

**Printed in U.S.A with permission by Curran Associates, Inc. (2020)**

**Additional copies of this publication are available from:**

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

## CONTENTS

### **39TH COMPUTERS AND INFORMATION IN ENGINEERING CONFERENCE**

#### **ADVANCED MODELING AND SIMULATION**

**DETC2019-97988..... V001T02A001**

Optimal Design of Thermo-Compression Bonding for Advanced Packaging System  
Under Uncertainty

*Sungkun Hwang, Seung-Kyum Choi*

**DETC2019-98150..... V001T02A002**

A Systematic Rapid Creative Design Framework for Complex Mechanical Systems  
From Conceptual Design to 3D Virtual Simulation

*Li Yu-Tong, Wang Yu-Xin*

**DETC2019-98247..... V001T02A003**

A Coarea Formulation for Grid-Based Evaluation of Volume Integrals  
*Christopher Uchytil, Duane Storti*

**DETC2019-98360..... V001T02A004**

Design of NRL66.4: An Electro-Hydraulic 6-DoF Parallel Robotic Multiaxial Material  
Testing System

*John G. Michopoulos, Athanasios P. Iliopoulos, John C. Steuben, Benjamin D. Gruber*

#### **ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN DESIGN AND MANUFACTURING**

**DETC2019-97095..... V001T02A005**

A Standardized Representation of Convolutional Neural Networks for Reliable  
Deployment of Machine Learning Models in the Manufacturing Industry  
*Max Ferguson, Seongwoon Jeong, Kincho H. Law, Svetlana Levitan, Anantha Narayanan,  
Rainer Burkhardt, Tridivesh Jena, Yung-Tsun Tina Lee*

**DETC2019-97378..... V001T02A006**

Automatically Generating 60,000 CAD Variants for Big Data Applications  
*Sachit Ramnath, Payam Haghighi, Ji Hoon Kim, Duane Detwiler, Michael Berry, Jami J.  
Shah, Nikola Aulig, Patricia Wollstadt, Stefan Menzel*

**DETC2019-97393..... V001T02A007**

Domain Randomization for Detection and Position Estimation of Multiples of a Single  
Object With Applications to Localizing Bolts on Structures  
*Ezra Ameperosa, Pranav A. Bhounsule*

**DETC2019-97610..... V001T02A008**

Machine Learning Assisted Prediction of the Manufacturability of Laser-Based Powder  
Bed Fusion Process  
*Ying Zhang, Guoying Dong, Sheng Yang, Yaoyao Fiona Zhao*

**DETC2019-97711..... V001T02A009**

Reinforcement Learning Content Generation for Virtual Reality Applications

*Christian E. Lopez, Omar Ashour, Conrad S. Tucker*

**DETC2019-98215..... V001T02A010**

From Scan Strategy to Melt Pool Prediction: A Neighboring-Effect Modeling Method

*Zhuo Yang, Lu Yan, Ho Yeung, Sundar Krishnamurty*

**DETC2019-98472..... V001T02A011**

Stress Field Prediction in Cantilevered Structures Using Convolutional Neural Networks

*Zhenguo Nie, Haoliang Jiang, Levent Burak Kara*

**DETC2019-98477..... V001T02A012**

Prediction of Nitrogen Concentration in Fuel Cells Using Data-Driven Modeling

*Tong Lin, Leiming Hu, Shawn Litster, Levent Burak Kara*

**DETC2019-98481..... V001T02A013**

Pixel to Stroke Sketch Generation Using Reinforcement Learning

*Haizhou Wang, Conrad Tucker*

## **COMPLEX SYSTEMS ENGINEERING AND DESIGN**

**DETC2019-97640..... V001T02A014**

Computational Design of Scheduling Strategies for Multi-Robot Cooperative 3D Printing

*Laxmi Poudel, Wenchao Zhou, Zhenghui Sha*

**DETC2019-98042..... V001T02A015**

Construction of Multi-Domain System Simulation Model for Trade Studies in System Design Considering Multiple Scenes

*Kazuya Oizumi, Keita Ishida, Yoshihiro Uchibori, Kazuhiro Aoyama*

**DETC2019-98248..... V001T02A016**

Finite-State Automata-Based Representation of Device States for Function Modeling and Formal Definitions of Signal-Processing Functions

*Ahmed Chowdhury, Xiaoyang Mao, Lakshmi N. A. Venkatanarasimhan, Chiradeep Sen*

**DETC2019-98255..... V001T02A017**

Toward a Functional Failure Analysis Method of Identifying and Mitigating Spurious System Emissions in a System of Systems

*Douglas L. Van Bossuyt, Ryan M. Arlitt*

## **COMPUTATIONAL MULTIPHYSICS APPLICATIONS**

**DETC2019-97514..... V001T02A018**

Improvement of Thermal Performance of Pin Fin Heat Sink Using Different Types of Perforations: A Study Under Natural Convection

*Aashish Kumar, Manoj Kumar Mondal*

**DETC2019-97677..... V001T02A019**

On the Effect of Glassy Coatings on the Wear of a Sliding Contact via Multiphysics Modeling

*John G. Michopoulos, Athanasios P. Iliopoulos, John C. Steuben, Andrew J. Birnbaum, Nicole A. Apetre*

**DETC2019-98008..... V001T02A020**

A Parametric Modeling Approach for Prediction of Load Distribution due to Fluid Structure Interaction on Aircraft Structures

*Ahmet Barutcu, Recep M. Gorguluarslan*

**DETC2019-98075..... V001T02A021**

Reverse Engineering and Optimization of a Steering Mechanism Component in a Competition Ground Vehicle

*Matheo Lopez-Pachon, Diego Gonzalez-Cardenas, Andres Gonzalez-Mancera*

## **COMPUTER-AIDED PRODUCT AND PROCESS DEVELOPMENT**

**DETC2019-97554..... V001T02A022**

Rapid Investment Casting: Design and Manufacturing Technologies

*Christopher T. Richard, Tszi-Ho Kwok*

**DETC2019-97801..... V001T02A023**

Investigating Usability of an Innovation Management Decision Aid

*Elizabeth Gendreau, Joshua D. Summers, Lamiae Benhayoun-Sadafiyine, Marie-Anne Le Dain*

**DETC2019-98069..... V001T02A024**

Development of Three-Nozzle Extrusion System for Conformal Multi-Resolution 3D Printing With a Robotic Manipulator

*Yeo Jung Yoon, Minsok Yon, Sung Eun Jung, Satyandra K. Gupta*

**DETC2019-98221..... V001T02A025**

A Spatial Linkage Exoskeleton for a Shape-Adaptive Mobile Robot

*David E. Geyer, Cameron J. Turner*

**DETC2019-98372..... V001T02A026**

Reconstruction of Gap-Free Intersections for Trimmed NURBS Surfaces

*Benjamin Urick, Richard H. Crawford, Thomas J. R. Hughes, Elaine Cohen, Richard F. Riesenfeld*

**DETC2019-98456..... V001T02A027**

Geometric Complexity Estimation of Continuous Surfaces for Fitting Processes

*Hossein Gohari Bahabadi, Ahmad Barari*

## **DESIGN INFORMATICS**

**DETC2019-97605..... V001T02A028**

Technology Knowledge Graph for Design Exploration: Application to Designing the Future of Flying Cars

*Serhad Sarica, Binyang Song, Jianxi Luo, Kristin Wood*

**DETC2019-97625..... V001T02A029**

A Deep Learning Based Approach to Predict Sequential Design Decisions

*Molla Hafizur Rahman, Charles Xie, Zhenghui Sha*

**DETC2019-97728..... V001T02A030**

Semantic Network Differences Across Engineering Design Communication Methods

*Christian E. Lopez, Zixuan V. Zhao, Conrad S. Tucker*

**DETC2019-98343..... V001T02A031**

Physics-Based Function Features for a Set of Material-Processing Verbs

*Lakshmi N. A. Venkatanarasimhan, Xiaoyang Mao, Ahmed Chowdhury, Chiradeep Sen*

## **DESIGN, SIMULATION, AND OPTIMIZATION FOR ADDITIVE MANUFACTURING**

**DETC2019-97684..... V001T02A032**

Simulation of Nucleation and Grain Growth in Selective Laser Melting of Ti-6Al-4V Alloy

*Dehao Liu, Yan Wang*

**DETC2019-97963..... V001T02A033**

Dimensional Prediction for FDM Machines Using Artificial Neural Network and Support Vector Regression

*Jiaqi Lyu, Souran Manoochehri*

**DETC2019-98046..... V001T02A034**

Towards Thermal Simulation of Powder Bed Fusion on Path Level

*Yaqi Zhang, Vadim Shapiro, Paul Witherell*

**DETC2019-98189..... V001T02A035**

Phase Transformation Advancements of the Enriched Analytic Solution Method for Additive Manufacturing Applications

*John C. Steuben, Andrew J. Birnbaum, Athanasios P. Iliopoulos, John G. Michopoulos*

**DETC2019-98195..... V001T02A036**

Towards Selective Volumetric Additive Manufacturing and Processing of Ceramics

*A. P. Iliopoulos, J. G. Michopoulos, J. C. Steuben, A. J. Birnbaum, B. D. Gruber, B. Y. Rock, L. A. Johnson, E. P. Gorzkowski*

**DETC2019-98204..... V001T02A037**

Design of Non-Periodic Lattice Structures by Allocating Pre-Optimized Building Blocks

*Haejoon Choi, Adrian Matias Chung Baek, Namhum Kim*

**DETC2019-98332..... V001T02A038**

Surrogate Models for the Efficient Estimation of Residual Fields Associated With Additively Manufactured Parts

*Athanasis P. Iliopoulos, John C. Steuben, Nicole A. Apetre, John G. Michopoulos*

**DETC2019-98351..... V001T02A039**

Electron Backscatter Diffraction-Enabled Anisotropic Thermo-Elastic Analysis of Additively Manufactured Single Tracks

*Andrew J. Birnbaum, John G. Michopoulos, John C. Steuben, Athanasios P. Iliopoulos*

**DETC2019-98415..... V001T02A040**

A Review of Machine Learning Applications in Additive Manufacturing

*Sayyeda Saadia Razvi, Shaw Feng, Anantha Narayanan, Yung-Tsun Tina Lee, Paul Witherell*

**DETC2019-98452..... V001T02A041**

Direct Solid Element Slicing in Topology Optimization for Additive Manufacturing

*Dylan Bender, Ahmad Barari*

**DETC2019-98458..... V001T02A042**

Enabling Performance Qualification of Additively Manufactured Parts Under Multiaxial Loading Emulating In-Service Conditions

*John G. Michopoulos, Athanasios P. Iliopoulos, John C. Steuben, Trung Nguyen, Nam Phan*

**DETC2019-98480..... V001T02A043**

Anisotropic Multicomponent Topology Optimization for Additive Manufacturing With Build Orientation Design and Stress-Constrained Interfaces

*Yuqing Zhou, Tsuyoshi Nomura, Kazuhiro Saitou*

## HUMAN MODELING: METHODS AND APPLICATIONS IN ENGINEERING

**DETC2019-97223..... V001T02A044**

Review of Models and Robotic Devices for Stroke Survivors' Upper Extremity Rehabilitation

*Shadman Tahmid, James Yang, Josep M. Font-Llagunes*

**DETC2019-97389..... V001T02A045**

Effects of Head Supported Mass on Predicted Neck Musculoskeletal Loadings During Walking and Running

*Xianlian Zhou, Xinyu Chen, Paulien E. Roos, Phillip Whitley*

**DETC2019-97520..... V001T02A046**

Muscle Force Prediction in OpenSim Using Skeleton Motion Optimization Results As Input Data

*Rahid Zaman, Yujiang Xiang, Ritwik Rakshit, James Yang*

**DETC2019-97784..... V001T02A047**

Optimal Camera Configuration for 3D Scanning of Human Hand

*Yusheng Yang, Willemijn S. Elkhuizen, Tao Hou, Tessa T. W. Essers, Yu Song*

**DETC2019-97826.....** **V001T02A048**  
Computational Fluid Dynamics Simulation of Flow of Exhaled Particles From  
Powered-Air Purifying Respirators  
*Susan S. Xu, Zhipeng Lei, Ziqing Zhuang, Michael Bergman*

**DETC2019-97889.....** **V001T02A049**  
A New Approach for Medical Assessment of Patient's Injured Shoulder  
*Andrea Vitali, Daniele Regazzoni, Caterina Rizzi, Federico Maffioletti*

**DETC2019-98043.....** **V001T02A050**  
A Customer-to-Manufacturer Design Model for Custom Compression Casts  
*Yunbo Zhang, Tsz-Ho Kwok*

**DETC2019-98466.....** **V001T02A051**  
Using Automated Use Case Generation for Early Design Stage Functional Failure and  
Human Error Analysis  
*Lukman Irshad, H. Onan Demirel, Irem Y. Turner*

## **KNOWLEDGE CAPTURE, REUSE, AND MANAGEMENT**

**DETC2019-98278.....** **V001T02A052**  
Modeling a Supply Chain Reference Ontology Based on a Top-Level Ontology  
*Farhad Ameri, Boonserm Kulvatunyou*

## **METHODS, PROCESSES, AND STRATEGIES FOR TECHNOLOGY**

**DETC2019-97340.....** **V001T02A053**  
Toolbox for User-Centered Specification of VR Systems  
*Andreas Liebal, Heidi Kromker, Atif Mahboob, Christian Weber*

**DETC2019-97341.....** **V001T02A054**  
Augmented Reality Interface: Guidelines for the Design of Contrast Ratios  
*Regina Koreng, Heidi Kromker*

**DETC2019-97519.....** **V001T02A055**  
Assessment of Joint Parameters in a Kinect Sensor Based Rehabilitation Game  
*Soumya K. Manna, Venketesh N. Dubey*

## **MOTIVATION AND EMOTION**

**DETC2019-97500.....** **V001T02A056**  
Effect of Assistive Methods on the Sense of Fulfillment With Agency: Modeling With  
Flow and Attribution Theories  
*Dan Nanno, Hideyoshi Yanagisawa*

**DETC2019-98030.....** **V001T02A057**  
Mahalanobis-Taguchi-Fukuda Approach to Human Motion Control  
*Shuichi Fukuda*

## **SIMULATION IN ADVANCED MANUFACTURING**

**DETC2019-97887..... V001T02A058**

Decentralized Informative Path Planning With Balanced Exploration-Exploitation for Swarm Robotic Search

*Payam Ghassemi, Souma Chowdhury*

**DETC2019-98076..... V001T02A059**

Job Shop Scheduling Optimization Using Genetic Algorithm With Global Criterion Technique

*Ke Xu, Souran Manoochehri*

**DETC2019-98234..... V001T02A060**

Optimal Reconfiguration Path Decision Method for One RMT System

*Sihan Huang, Cong Zeng, Guoxin Wang, Yan Yan*

## **SMART MANUFACTURING INFORMATICS**

**DETC2019-97130..... V001T02A061**

Framework for Design From Manufacturing Data Mapping

*Douglas Eddy, Sundar Krishnamurti, Ian Grosse, Mark Steudel, Mike Shimazu*

**DETC2019-97134..... V001T02A062**

On Practice and Theory of Constructive Composite Geometry and Topology

*Thomas D. Hedberg Jr., Allison Barnard Feeney, Vijay Srinivasan*

**DETC2019-97151..... V001T02A063**

Digital Twins for Space Factory 4.0

*Thiago Weber Martins, Reiner Anderl*

**DETC2019-97692..... V001T02A064**

A Framework for Automating Maynard Operation Sequence Technique Studies

*Rahul Sharan Renu*

**DETC2019-98378..... V001T02A065**

Extraction and Analysis of Spatial Correlation Micrograph Features for Traceability in Manufacturing

*Adam Dachowicz, Mikhail Atallah, Jitesh H. Panchal*

## **SYSTEMS ENGINEERING**

**DETC2019-98081..... V001T02A066**

Modeling and Analysis of Subsystem Interactions in Robotic Assembly

*Shaurya Shriyam, Satyandra K. Gupta*

**DETC2019-98181..... V001T02A067**

Topological Semantics for Lumped Parameter Systems Modeling

*Randi Wang, Vadim Shapiro*

**DETC2019-98420.....** V001T02A068  
Spacecraft Failure Analysis From the Perspective of Design Decision-Making  
*Vikranth Kattakuri, Jitesh H. Panchal*

**DETC2019-98502.....** V001T02A069  
A Physics-Based Formal Vocabulary of Energy Verbs for Function Modeling  
*Chiradeep Sen, Joshua D. Summers, Xiaoyang Mao*

## **UNCERTAINTY QUANTIFICATION IN SIMULATION AND MODEL VERIFICATION AND VALIDATION**

**DETC2019-97764.....** V001T02A070  
Stochastic Simulation of Turbine Engine Component Under Aleatory and Epistemic  
Uncertainty  
*Austin M. McKeand, Recep M. Gorguluarslan, Seung-Kyum Choi*

**DETC2019-97766.....** V001T02A071  
Model Based Root Cause Analysis of Manufacturing Quality Problems Using  
Uncertainty Quantification and Sensitivity Analysis  
*Kevin Otto, Josefina Sanchez Mosqueda*

**DETC2019-97954.....** V001T02A072  
Model Bias Characterization for Effective States Estimation of Lithium-Ion Batteries  
*Modjtaba Dahmardeh, Zhimin Xi*

**DETC2019-97986.....** V001T02A073  
sBF-BO-2CoGP: A Sequential Bi-Fidelity Constrained Bayesian Optimization for  
Design Applications  
*Anh Tran, Tim Wildey, Scott McCann*

**DETC2019-98099.....** V001T02A074  
Deep Active Subspaces: A Scalable Method for High-Dimensional Uncertainty  
Propagation  
*Rohit Tripathy, Ilias Bilionis*

**DETC2019-98202.....** V001T02A075  
A Reliability Model Validation Method for Mitigating the Effects of Measurement  
Uncertainty  
*Mohammadkazem Sadoughi, Meng Li, Joseph Beck, Chao Hu*

**DETC2019-98490.....** V001T02A076  
A Performance Comprehension of Various Numerical Estimators for Variance-Based  
Sensitivity Analysis in Building Energy Simulations  
*Rasool Koosha, Fatemeh Shahsavari*

**DETC2019-98510.....** V001T02A077  
An Uncertainty and Sensitivity Analysis Tool for Building Thermal Energy  
Consumption: A Performance Comprehension of Static and Dynamic Response  
Analyses  
*Rasool Koosha, Fatemeh Shahsavari*

## VIRTUAL ENVIRONMENTS AND SYSTEMS

**DETC2019-97160.....** V001T02A078

Sparse Scaling Iterative Closest Point for Rail Profile Inspection

*Yue Yang, Long Liu, Bing Yi*

**DETC2019-97173.....** V001T02A079

Smartphone As a Stand-Alone Device for Rendering, Visualization and Tracking for Use During Product Development in Virtual Reality (VR)

*Atif Mahboob, Stephan Husung, Christian Weber, Andreas Liebal, Heidi Kromker*

**DETC2019-97415.....** V001T02A080

Using Virtual Reality to Test Human-Robot Interaction During a Collaborative Task

*Roberta Etzi, Siyuan Huang, Giulia Wally Scurati, Shilei Lyu, Francesco Ferrise, Alberto Gallace, Andrea Gaggioli, Alice Chirico, Marina Carulli, Monica Bordegoni*

**DETC2019-97836.....** V001T02A081

A Multisensory Virtual Reality System for Astronauts' Entertainment and Relaxation

*Marina Carulli, Monica Bordegoni, Francesca Bernechich, Elena Spadoni, Patrizia Bolzan*

**DETC2019-97844.....** V001T02A082

An Augmented Reality-Based Training System for Manual Milling Operations

*Tung-Jui Chuang, Chih-Kai Yang, Shana Smith*

**DETC2019-97926.....** V001T02A083

Towards a Broad Use of Gamification Based on Hand Tracking in Post Stroke Patients

*Daniele Regazzoni, Andrea Vitali, Caterina Rizzi*

**DETC2019-98186.....** V001T02A084

Do Autonomous Vehicle Driving Styles Affect User State?: A Preliminary Investigation

*Yuan Shi, Wenhui Huang, Federico Cheli, Monica Bordegoni, Giandomenico Caruso*

**DETC2019-98440.....** V001T02A085

Mobile Based Real-Time Occlusion Between Real and Digital Objects in Augmented Reality

*Pranav Jain, Conrad Tucker*