### Contents

Multi-agent based Architecture for Acknowledged System of Systems  
S. Agarwal, L.E. Pape, N. Kilicy-Ergin, C.H. Dagli  
1

System of Systems Acquisition Trade-offs  
F.R. Burton, R.F. Paige, S. Paulding, S. Smith  
11

Human System Integration Ontology: Enhancing Model based Systems Engineering to Evaluate Human-system Performance  
D.W. Orellana, A.M. Madni  
19

Increasing Systems Resilience through the Implementation of a Proactive Technology Refreshment Program  
A. Sols  
26

Assessment of Production System Alternatives During Early Development Phase  
V. Rutsch, J. Gausmeier, G. Rehaug  
34

The Essential Nature of Product Traceability and its Relation to Agile Approaches  
K.D. Palmer  
44

Experimental Trials based on a Neocortex-based Adaptive System Pattern  
B.J. Phillips, M. Blackburn  
54

Improving Cyber Resiliency of Cloud Application Services by Applying Software Behavior Encryption (SBE)  
D. Thebeau II, B. Reidy, R. Valerdi, A. Gudagi, H. Kurra, Y. Al-Nashif, S. Hariri, F. Sheldon  
62

Systems Approach to the Development and Application of Technical Metrics to Systems Engineering Projects  
D. Gilbert, M. Yearworth, L. Oliver  
71

Conceptual Modeling of the Impact of Smart Cities on Household Energy Consumption  
N. Khansari, A. Mostashari, M. Mansouri  
81

Modifying the X-Matrix to Capture the Joint Capability Architecture  
J.R. Enos  
87

Exploiting Architectural Communities in Early Life Cycle Cost Estimation  
M. Dabkowski, R. Valerdi, J. Farr  
95

Future Alternatives for Automotive Configuration Management  
J. Landahl, D. Bergejö, H. Johannesson  
103

Exploring Beliefs about Using Systems Engineering to Capture Contracts  
C. Smartt, S. Ferreira  
111

A Framework for Optimizing the Use of Systems Engineering on Proposals  
C. Smartt, S. Ferreira, J. Rosenberger, H.W. Corley  
120

Managing Attribute Complexity for User-centered Decision Support Systems  
M. Ölmez, U. Lindemann  
130

Planning for Resilient Lean Programs  
D. Secor, S. Lucae, E. Rebentisch  
138

Abstractions for Executable and Checkable Fault Management Models  
C. Gibson, R. Karban, L. Andolfato, J. Day  
146

Enabling Extracorporeal Membrane Oxygenation (ECMO) Community Collaboration via Systems Engineering Methodologies  
S. Blaock, E. Chanez, B. Doncaster, B.A. Majeed, A. Pate, D. Stoute  
155

Optimal Modularity for Fractionated Spacecraft: The Case of System F6  
M. Mosleh, K. Dalili, B. Heydari  
164

Early Insight in Systems Design through Modeling and Simulation  
S.P. Haveman, G.M. Bonnema, F.G.B. van den Berg  
171

Designing Networked Energy Infrastructures with Architectural Flexibility  
Y.G. Melesa, P.W. Heijnen, R.M. Stikkelman  
179

Bridging the Gap between Systems and Software Engineering by Using the SPES Modeling Framework as a General Systems Engineering Philosophy  
W. Böhm, S. Henkler, F. Houdek, A. Vogelsang, T. Weyer  
187

Development of a Modeling Language to Connect Features, Functions and Components  
A. Grewe, M. Ibe, F. Nehuis, A. Rausch, T. Vietor  
195

Linking Normative and Descriptive Research with Serious Gaming  
S.D. Vermillion, R.J. Malak, R. Smallman, S. Fields  
204

Applying Systems Thinking to Analyze Wind Energy Sustainability  
J. Tejeda, S. Ferreira  
213

doi:10.1016/S1877-0509(14)00172-0
iv

Contents

A Requirements Management System based on an Optimization Model of the Design Process
N.W. Mogk .......................................................................................................................... 221

A Systematic Method for Specifying Effective Value Models
B.D. Lee, W.R. Binder, C.J.J. Paredis .............................................................................. 228

Empowering Requirements Engineering Activities with Personas
W.W. Sim, P.S. Brouse ...................................................................................................... 237

An Adaptive and Preemptive Theory for Improving Systemic IT Project Failure Trends (“AdaPIT” Theory)
R. Stoica, P. Brouse .......................................................................................................... 247

Resilience-based System Importance Measures for System-of-Systems
P. Uday, K.B. Marais ......................................................................................................... 257

Towards Global Deviation Management in Product Development Using Pulse Methodology: A Case Study
O. Kaya, D. Stenholm, A. Catic, D. Bergsjo ................................................................. 265

Exploring the Possibilities of Using Image Recognition Technology to Create a Hybrid Lean System for Pulse Methodology
O. Kaya, A. Catic, D. Bergsjo ............................................................................................ 275

Resilience in Large Scale Distributed Systems

Exploring Stakeholder Value Models via Interactive Visualization
N. Ricci, M.A. Schaffner, A.M. Ross, D.H. Rhodes, M.E. Fitzgerald ........... 294

A Method for Selecting Affordable System Concepts: A Case Application to Naval Ship Design
M.A. Schaffner, A.M. Ross, D.H. Rhodes ........................................................................ 304

Evolvability-related Options in Military Systems of Systems
N. Ricci, D.H. Rhodes, A.M. Ross .................................................................................... 314

Architecting Systems of Systems with Saites: An Overview of the SAI Method
N. Ricci, M.E. Fitzgerald, A.M. Ross, D.H. Rhodes .................................................... 322

n-Tiered Test Automation Architecture for Agile Software Systems
P. Day ................................................................................................................................. 332

A Systems Engineering Approach to Quantitative Comparison of Molecular Instruments for Use on the International Space Station
K. Oleavegerber, J. Levit, D.J. Smith, T. Van Nguyen, A.M. Peter ..................... 340

Predicting Systems Performance through Requirements Quality Attributes Model
J.L. Dargan, E. Campos-Nanez, P. Fomin, J. Wasek ................................................. 347

An Approach to Identifying Inconsistencies in Model-based Systems Engineering
S.J.J. Herzig, A. Qamar, C.J.J. Paredis ........................................................................... 354

A Hybrid System Engineering Approach for Engineered Resilient Systems: Combining Traditional and Agile Techniques to Support Future System Growth
S. Virani, L. Stolzar ........................................................................................................ 363

Analyzing K-12 Education as a Complex System
P. Mital, R. Moore, D. Llewellyn .................................................................................... 370

Using Social Network Analysis to Investigate the Potential of Innovation Networks: Lessons Learned from NASA’s International Space Apps Challenge
F. Senghore, E. Campos-Nanez, P. Fomin, J.S. Wasek ............................................. 380

Developing a Method to Evaluate Entropy in Organizational Systems
H.A. Martínez-Berumen, G.C. López-Torres, L. Romo-Rojas ....................... 389

The Value Proposition for Assurance of JPL Systems
D. Port, J. Wilf .................................................................................................................. 398

Fuzzy Optimization of Acknowledged System of Systems Meta-architectures for Agent based Modeling of Development
L. Pape, S. Agarwal, K. Giammarco, C. Dagli .............................................................. 404

Controlling for Framing Effects in Multi-Stakeholder Tradespace Exploration
M.E. Fitzgerald, A.M. Ross ............................................................................................ 412

High Profile Systems Illustrating Contradistinctive Aspects of Systems Engineering
A. Burbidge, L. Doyle, M. Pennotti ................................................................................ 422

Game-based Learning for Systems Engineering Concepts
A.M. Ross, M.E. Fitzgerald, D.H. Rhodes ...................................................................... 430

Curiosity’s Fault Tolerant Wakeup and Shutdown Design
T.A. Neilson, J.A. Donaldson ........................................................................................... 441

Dynamic Planning of System of Systems Architecture Evolution
Z. Fang, D. DeLaurentis ................................................................................................. 449

Residential Power Load Forecasting
J. Maurio, C. McClure ...................................................................................................... 465

Emotions and the Engineering of Adaptiveness in Complex Systems
M.G. Sánchez-Escribano, R. Sanz .................................................................................. 473
## Contents

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reusable Derivation of Operational Metrics for Architectural Optimization</td>
<td>481</td>
</tr>
<tr>
<td>M. Masin, H. Broodney, C. Brown, L. Limonad, N. Mashkif, A. Sela</td>
<td></td>
</tr>
<tr>
<td>Robust Optimization of System Design</td>
<td>489</td>
</tr>
<tr>
<td>E. Shindin, O. Boni, M. Masin</td>
<td></td>
</tr>
<tr>
<td>Verifying the Abstraction Level of Structural Models</td>
<td>497</td>
</tr>
<tr>
<td>M. Roth, D. Kaspereck, U. Lindemann</td>
<td></td>
</tr>
<tr>
<td>On Technical Credit</td>
<td>505</td>
</tr>
<tr>
<td>B. Berenbach</td>
<td></td>
</tr>
<tr>
<td>A Model-based Framework for Predicting Performance in Self-adaptive Systems</td>
<td>513</td>
</tr>
<tr>
<td>S.H. Young, T.A. Mazzuchi, S. Sarkani</td>
<td></td>
</tr>
<tr>
<td>Cyber Defense of Space-based Assets: Verifying and Validating Defensive Designs and Implementations</td>
<td>522</td>
</tr>
<tr>
<td>D.J. Byrne, D. Morgan, K. Tan, B. Johnson, C. Dorros</td>
<td></td>
</tr>
<tr>
<td>Multi-view Modeling in SysML: Thematic Structuring for Multiple Thematic Views</td>
<td>531</td>
</tr>
<tr>
<td>M. Florian, A. Albert, W. Daniel, B. Matthias</td>
<td></td>
</tr>
<tr>
<td>The Concept of Problem Complexity</td>
<td>539</td>
</tr>
<tr>
<td>Increasing the Probability of Developing Affordable Systems by Maximizing and Adapting the Solution Space</td>
<td>547</td>
</tr>
<tr>
<td>A. Salado, R. Nilchiani</td>
<td></td>
</tr>
<tr>
<td>A Formal Method for Assessing Architecture Model and Design Maturity Using Domain-independent Patterns</td>
<td>555</td>
</tr>
<tr>
<td>K. Giammarco</td>
<td></td>
</tr>
<tr>
<td>Resilience Analysis of Soft Infrastructure Systems</td>
<td>565</td>
</tr>
<tr>
<td>M. Omer, A. Mostashari, U. Lindemann</td>
<td></td>
</tr>
<tr>
<td>Mitigating the Risk of Cyber Attack on Smart Grid Systems</td>
<td>575</td>
</tr>
<tr>
<td>E.B. Rice, A. AlMajali</td>
<td></td>
</tr>
<tr>
<td>The Capability Assessment and Tradeoff Environment (CATE) for Advanced Aerospace Vehicle and Technology Assessment</td>
<td>583</td>
</tr>
<tr>
<td>J. Arruda, A. Gavrilovski, B. Ahn, H.-G. Chae, E. Spero, D.N. Mavris</td>
<td></td>
</tr>
<tr>
<td>Tradespace Exploration for the Engineering of Resilient Systems</td>
<td>591</td>
</tr>
<tr>
<td>E. Spero, M.P. Avera, P.E. Valdez, S.R. Goerger</td>
<td></td>
</tr>
<tr>
<td>Wholistic Sustainment Maturity: The Extension of System Readiness Methodology across All Phases of the Lifecycle of a Complex System</td>
<td>601</td>
</tr>
<tr>
<td>B. Atrwater, J. Udzinski</td>
<td></td>
</tr>
<tr>
<td>A Systems Approach to Healthcare Efficiency Improvement</td>
<td>610</td>
</tr>
<tr>
<td>J. Monreal, Jr. R. Valerdi, L.D. Latt</td>
<td></td>
</tr>
<tr>
<td>Blended Wing Body Architecting and Design: Current Status and Future Prospects</td>
<td>619</td>
</tr>
<tr>
<td>E. Ordoukhanian, A.M. Madni</td>
<td></td>
</tr>
<tr>
<td>Decomposition Relationship Visualization for Executable Architecture Diagrams</td>
<td>626</td>
</tr>
<tr>
<td>J.C. Lew, K.M. Giammarco</td>
<td></td>
</tr>
<tr>
<td>An Unambiguous Language for Systems Process Design and Engineering</td>
<td>635</td>
</tr>
<tr>
<td>J. Ring, L. Troncale</td>
<td></td>
</tr>
<tr>
<td>Designing Workshops for the Introduction of Lean Enablers to Engineering Programs</td>
<td>643</td>
</tr>
<tr>
<td>K. Gersing, J. Oehmen, E. Rebentisch</td>
<td></td>
</tr>
<tr>
<td>Understanding the Front-end of Large-scale Engineering Programs</td>
<td>653</td>
</tr>
<tr>
<td>S. Lucce, E. Rebentisch, J. Oehmen</td>
<td></td>
</tr>
<tr>
<td>Sysinformatics &amp; Systems Mimicry: New Fields Emerging from a “Science” of Systems Processes Engineering</td>
<td>663</td>
</tr>
<tr>
<td>L. Troncale</td>
<td></td>
</tr>
<tr>
<td>Virtual Systems Research II: Using Systems Process Theory</td>
<td>672</td>
</tr>
<tr>
<td>L. Friendshuh, L. Troncale</td>
<td></td>
</tr>
<tr>
<td>Design for System Lifecycle Properties—A Generic Approach for Modularizing Systems</td>
<td>682</td>
</tr>
<tr>
<td>F. Schoettl, U. Lindemann</td>
<td></td>
</tr>
<tr>
<td>An Investigation of MBSE Practices Across the Contractual Boundary</td>
<td>692</td>
</tr>
<tr>
<td>Q. Do, S. Cook, M. Lay</td>
<td></td>
</tr>
<tr>
<td>An Analytic Workbench Perspective to Evolution of System of Systems Architectures</td>
<td>702</td>
</tr>
<tr>
<td>N. Davendralingam, D. DeLaurentans, Z. Fang, C. Guariniello, S.Y. Han, K. Marais, A. Mour, P. Uday</td>
<td></td>
</tr>
<tr>
<td>An Analytic Portfolio Approach to System of Systems Evolutions</td>
<td>711</td>
</tr>
<tr>
<td>N. Davendralingam, D. DeLaurentans</td>
<td></td>
</tr>
<tr>
<td>C. Guariniello, D. DeLaurentans</td>
<td></td>
</tr>
<tr>
<td>C. Guariniello, D. DeLaurentans</td>
<td></td>
</tr>
<tr>
<td>Modeling of Emotional Effects on Decision-making by Game Agents</td>
<td>736</td>
</tr>
<tr>
<td>M. Spraragen, A.M. Madni</td>
<td></td>
</tr>
</tbody>
</table>
## Contents

Integrating Acquisition Strategy and PMO Capability: A Catalyst for Defense Systems Engineering Transformation  
C.M. Farmer, T.A. Marzuchi, S. Sarkani .......................................................... 744

Provider Reactions to an Automated Telephone Tool to Screen and Monitor Depression in a Safety Net Population  
P. Di Capua, S. Wu .......................................................... 754

A Research Agenda for Tradespace Exploration and Analysis of Engineered Resilient Systems  
E. Spero, C.L. Bloebaum, B.J. German, A. Pyster, A.M. Ross ....................... 763

Bandwidth Allocation in Tactical Data Links via Mechanism Design  
A. Mour, D. De Laurentis .............................................. 773

Extended Model for Integrated Value Engineering  
F.G.H. Behncke, S. Maisenbacher, M. Maurer ........................................... 781

What to Measure for Success in Lean System Engineering Programs?  

The Digital Battlefield: A Behind-the-Scenes Look from a Systems Perspective  
N.G. Siegel, A.M. Madni .................................................. 799

Toward a Resilience Framework for Sustainable Engineered Systems  
M. Rahimi, A.M. Madni .................................................. 809

Integrated Agent-based Modeling and Optimization in Complex Systems Analysis  
J. Humann, A.M. Madni .................................................. 818

Design for Affordability in Complex Systems and Programs Using Tradespace-based Affordability Analysis  
M.S. Wu, A.M. Ross, D.H. Rhodes ........................................... 828

Cyber Resiliency Engineering Overview of the Architectural Assessment Process  
D.J. Bodeau, R.D. Graubart, E.R. Laderman ........................................... 838

Toward an Experiential Design Language: Augmenting Model-based Systems Engineering with Technical Storytelling in Virtual Worlds  
A.M. Madni, M. Nance, M. Richey, W. Hubbard, L. Hanneman ..................... 848

A Complex Sociotechnical Systems Approach to Provisioning Educational Policies for Future Workforce  
M. Richey, M. Nance, L. Hanneman, W. Hubbard, A.M. Madni, M. Spraragen .................................................. 857

Engineered Resilient Systems: A DoD Perspective  
S.R. Goerger, A.M. Madni, O.J. Eslinger ........................................... 865

Resilience Analysis of Soft Infrastructure Systems  
M. Omer, A. Mostashari, U. Lindemann ........................................... 873

Virtual Design and Verification of Cyber-physical Systems: Industrial Process Plant Design  
M. Blackburn, P. Denno .................................................. 883