# TABLE OF CONTENTS

Please note that the number preceding paper title is an identification number to be used in conjunction with the Symposium spiral-bound final program, abstract book and CD ROM.

## SECTION I: SYSTEM ENGINEERING APPLICATIONS

### Health Care Applications 3

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.1</td>
<td>A Systems Engineer's Approach to Brain Surgery</td>
<td>W.F. Mackey</td>
<td>3</td>
</tr>
<tr>
<td>3.1.2</td>
<td>Intelligent Agent Technology in the Health Care Environment</td>
<td>D.J. Simons</td>
<td>13</td>
</tr>
<tr>
<td>3.1.3</td>
<td>The Application of Systems Engineering to Telemedicine</td>
<td>S.J. Chorley</td>
<td>19</td>
</tr>
<tr>
<td>3.1.4</td>
<td>Predictive Performance Analysis and System/Software Architecture</td>
<td>Y. Lacerte</td>
<td>25</td>
</tr>
</tbody>
</table>

### Vehicles/Transportation 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1.1</td>
<td>Modular Vehicle Architectures: A Systems Approach</td>
<td>G.J. Rushton, A. Zakarian</td>
<td>29</td>
</tr>
<tr>
<td>5.1.2</td>
<td>Chances for Systems Engineering in Road Transport and Traffic Telematics</td>
<td>J.N. Hadderingh</td>
<td>37</td>
</tr>
<tr>
<td>5.1.3</td>
<td>Traceability in a Unified Systems Engineering Framework for a High Speed Railway System</td>
<td>Y.W. Park, H.S. Song, H.C. Chung</td>
<td>43</td>
</tr>
</tbody>
</table>

### Infrastructure Systems Engineering Applications

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1.1</td>
<td>Effective Control in Peopled Systems</td>
<td>J. Ring</td>
<td>57</td>
</tr>
<tr>
<td>6.1.2</td>
<td>Assessment of System Engineering Compliance in a Facilities Environment</td>
<td>R.R. Matty</td>
<td>65</td>
</tr>
<tr>
<td>6.1.3</td>
<td>Systems Engineering and Supportability Analysis: Technology Refreshment for COTS-Intensive Systems</td>
<td>D. Verma, G. Plunkett</td>
<td>69</td>
</tr>
<tr>
<td>6.1.4</td>
<td>The Telecommunication Domain - A Challenge for INCOSE</td>
<td>R. Kaffenberger</td>
<td>77</td>
</tr>
</tbody>
</table>

### Environmental Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1.1</td>
<td>A Systematic Approach to Environmental Legislation</td>
<td>C.M. Plowman, D.W. Nipper, B.M. Gardner</td>
<td>85</td>
</tr>
<tr>
<td>7.1.2</td>
<td>Abatement of Nonpoint Source Pollution: A Systems Engineering Model</td>
<td>B. Ghahramani, B. Elmaimani, T. Pope</td>
<td>93</td>
</tr>
<tr>
<td>7.1.3</td>
<td>Radioactive Material Transportation Requirements for the Department of Energy</td>
<td>T.W. Bolander, M.E. John, R.L. Fawcett</td>
<td>101</td>
</tr>
<tr>
<td>7.1.4</td>
<td>Identifying and Modeling Safety Hazards</td>
<td>J. Daniels, A.T. Bahill, P.W. Werner</td>
<td>107</td>
</tr>
</tbody>
</table>
Legal and Public Interest

8.1.1 Systems Engineering and the Legal Profession - Revisited
W.F. Mackey ................................................................. 115

8.1.2 Systems Engineering in a Public Interest Project: Providing a Web Based Communications Capability
J.V. Roberson, G.C. Bauknight ........................................... 127

8.1.3 Applying Engineering Principles to Human Components in Complex Systems
H. Kurstedt ................................................................. 135

8.1.4 Military and Civil Logistic Support of Humanitarian Relief Operations
M.W. Ludema, H.B. Roos .................................................. 143

SECTION II: MODELING AND SIMULATION

Tools
1.2.1 Realizing Complete Traceability With an Integrated Systems Engineering Environment (ISEE)
S.A. Hyer, M.W. Jones ....................................................... 153

1.2.2 Engineering of Complex Adaptive Systems Using OpEMCSS
J.R. Clymer ................................................................. 159

1.2.3 Web-based Aerospace System Evaluation Software: The Development and Assessment of Conceptual Space Missions
B.J. Makins, D.W. Miller ................................................... 167

1.2.4 A Web-Enabled, Collaborative Solution for Product Development: The Enterprise Process Analysis Toolkit for Affordability (ePATA)
R.D. Moulder, B.R. Reed, Jr. ................................................. 175

Modeling 2
3.2.1 Progress Towards Systems Modelling for the Extended Enterprise
P.F. Sims, A. Epifanie, C. Fitzgerald, J. Lott, D. Miles I. Plastow, C. Slack .......... 183

3.2.2 System Design and Validation Through Modeling and Simulation
D.G. Garrett, J. Wolff, T.F. Johnson ....................................... 189

3.2.3 The Use of an Information Model to Describe the SIRTF Spacecraft
J.A. Harrison ............................................................... 199

3.2.4 A Toolset for Modellbased AOCS-Design
F. Hoecherl, M. Wilke, O. Quirmbach, M. Surauer, E. Igenbergs .......................... 209

Modeling 3
4.2.1 Emergence: A Challenge for the Systematic
G.R. McConnell ............................................................. 215

4.2.2 The Perception-Reaction Simulation Model for Enterprise Control Systems
R.D. Gibson ............................................................... 221

4.2.3 Cost Engineering Within a Model-Based Design Process for Satellite Systems
O. Quirmbach, M. Wilke, E. Igenbergs .................................... 229

4.2.4 Guiding Principles for Next Generation Computer-Aided Systems Engineering Tools
M.E. Sampson ............................................................. 237

Systems
7.2.1 A Data Structure Approach to Systems Engineering
D.J. Battersby ............................................................... 247

7.2.2 Selection of a Requirement Management Tool for a Semi-Custom Design Company
D.G. Langston, M.L. Hansen .............................................. 255
7.2.3 A Generic Approach to Implement Information-Based System Development  
E. Fricke, A.P. Schulz, P. Wehlitz, H. Negele  
263

7.2.4 Discovering The Value of Systems Engineering  
J. Ring  
271

SECTION III: SYSTEM ENGINEERING MANAGEMENT

Management 1
1.3.1 Design-to-Market - From Product Development to Market Potential  
A. Vollerthun, E. Igenbergs  
281

1.3.2 Towards a Common Management Process for Projects, Systems Engineering and Software Development  
J.K. Davies  
291

1.3.3 Are Formal Methods Ready for Prime Time? The Use of Formal Methods in Developing Large Software Systems  
T.S. Ankrum  
299

1.3.4 Three Types of Systems Engineering Implementation  
S.A. Sheard  
307

Management 2
2.3.1 Examining the Necessity and Benefits of Systems Engineering in the Trenches  
G.G. Chapin  
315

2.3.2 Implementing Systems Engineering  
J.R. Armstrong  
325

2.3.3 Fuzzy Sets as Requirements Antecedents  
R.S. Carson  
331

2.3.4 Five Realities for Systems Engineering in Commercial Enterprises  
V.A. Lentz  
339

Management 4
4.3.1 Acquisition Strategies for the Management of Multinational Cooperative Research and Development Programs  
C.L. Roe  
347

4.3.2 Assessing the Relevance of Systems Engineering for Electrical Commercial Product Development  
O. Parrot, C. De Paoli, A. Rouge, C. Dutey  
353

4.3.3 Exploring Concepts During Pre-System Definition  
W.W. Schoening  
361

4.3.4 Role of Design, Design Validation, and Verification Activities in Development of Software Systems  
D. Kaslow  
369

Requirements
6.3.1 Properties of a High Quality Informal Requirements Document  
R.E. Schneider, D.M. Buede  
377

6.3.2 End User Involvement in Establishing Software Requirements for Aerospace Software Systems  
B. Ippolito, E. Murman  
385

6.3.3 Commercial System Development Models  
T. Cathcart, J.O. Grady, R. Jain, D. Surber  
393

6.3.4 Approaches to Certification of Reconfigurable IMA Systems  
P. Hollow, J. McDermid, M. Nicholson  
397
Risk 2

8.3.1 An Instrument for Establishing the Operational Need for the Dutch Defense
   M.W. Ludema ........................................................................................................ 405

8.3.2 Risk Reduction Through Changing Success Criteria
   D. McKinney ......................................................................................................... 413

8.3.3 Risk Management for the NASA/JPL Genesis Mission: A Case Study
   B.B. Roberts, R.B. Bennett .................................................................................... 421

8.3.4 The Relationship of Technology Change Management to Risk Management
   S.P. Mosier, S.A. Guenterberg, R.R. Raphael ....................................................... 429

SECTION IV: SYSTEM ANALYSIS/PROCESS

Architecture

1.4.1 A Development Guide of Robust System Architecture
   I.S. Yoo, J.C. Kim, Y.W. Park .............................................................................. 437

1.4.2 Global System Architecture Optimization: Quantifying System Complexity
   R.S. Carson ............................................................................................................. 443

1.4.3 Safety Assessment of System Architectures
   J. Murdoch, P. Kirkham, J.A. McDermid, P. Wilkinson ..................................... 449

1.4.4 Rapid Architecting Based on Systems Engineering Principles
   F. Harzenetter, B. Thomé, E. Igenbergs ................................................................. 457

Methods 2

3.4.1 Systems Engineering Meta-Tools for Complex Product Development
   H. Negele, S. Wenzel .............................................................................................. 465

3.4.2 Improving Systems Integrity by Using Thread Analysis for Design Validation
   R. Collins, P. Pearson, P. Chattaway ..................................................................... 473

3.4.3 Architecture Based Design Applied to a Remote Sensing Satellite Planner
   D. Kaslow ................................................................................................................ 483

3.4.4 A Systematic Method for Development of Reactive Real-Time Systems
   A. Grigg, N. Henderson ......................................................................................... 489

Methods 3

4.4.1 A Collaborative Systems Engineering Approach for Achieving Early Landing Gear
   Systems Maturity
   A. Mussad ............................................................................................................. 495

4.4.2 Risk and Performance
   F.J. Snyder, D.M. Buede ....................................................................................... 503

4.4.3 Using A System Object Methodology in Software Intensive Systems
   R.B. Wray ................................................................................................................ 511

4.4.4 Adapting UML for an Object Oriented Systems Engineering Method (OOSEM)
   H. Lykins, S. Friedenthal, A. Meilich ................................................................. 519

Methods 4

5.4.1 Systems Engineering Process Implementation in the Real World (Or Where the Theory Gets Tested)
   D.W. Newbern, J.T. Nolle ..................................................................................... 527

5.4.2 An Advanced Methodology for the Design Process of a Satellite
   H. Stoewer, R. Hartmann, L.A.J. Baron von Richter ........................................... 535
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.4.3</td>
<td>A Case Study in Modeling Company Policy Documents as a Source of Requirements</td>
<td>K.M. Crumpton, R.M. Gonzales, S. Trauth</td>
<td>543</td>
</tr>
<tr>
<td>5.4.4</td>
<td>An Integrated Information Representation Schema for Complex Human Centric Systems</td>
<td>H.E. Crisp, N. Hoang, C. Nguyen, N. Karangelen, D. Britton</td>
<td>551</td>
</tr>
<tr>
<td>Life Cycle 1</td>
<td>Reuse and COTS Lessons Learned for the Development Process and Team of Surveillance Radars</td>
<td>K. McGuire</td>
<td>559</td>
</tr>
<tr>
<td></td>
<td>The Systems Engineering Started in the Middle Process</td>
<td>A.T. Bahill, C. Briggs</td>
<td>565</td>
</tr>
<tr>
<td>Life Cycle 2</td>
<td>One Engineering Process - Integrated!</td>
<td>B. Denny, R. Bennett</td>
<td>591</td>
</tr>
<tr>
<td></td>
<td>Enabling Changes in Systems Throughout the Entire Life-Cycle - Key to Success?</td>
<td>A.P. Schulz, E. Fricke, E. Igenbergs</td>
<td>599</td>
</tr>
<tr>
<td></td>
<td>COTS: what you Get (In Addition to the Potential Development Savings)</td>
<td>J.E. Long</td>
<td>609</td>
</tr>
<tr>
<td></td>
<td>The Discovery Based Development Approach: A Process Aberration or A Better Way to Develop Complex Applications?</td>
<td>J.K. Shupp</td>
<td>613</td>
</tr>
<tr>
<td>SECTION V: MEASUREMENT</td>
<td>Capability Assessment 1</td>
<td>Tailoring the EIA/IS-731.2 Questionnaire</td>
<td>A.L. Dustin, C.J. Graden</td>
</tr>
<tr>
<td></td>
<td>An Innovative Adaptation of the EIA/IS 731.2 Systems Engineering Capability Model Appraisal Method</td>
<td>C.J. Graden, D.W. Nipper</td>
<td>629</td>
</tr>
<tr>
<td></td>
<td>SCE II™: Comprehensive, Integrated System Measurement During Use</td>
<td>G.P. Rust</td>
<td>635</td>
</tr>
<tr>
<td></td>
<td>Using an Integrated Capability Maturity Model® - The FAA Experience</td>
<td>L. Ibrahim</td>
<td>643</td>
</tr>
<tr>
<td></td>
<td>Continuous Appraisal Method (CAM)...A New Paradigm for Benchmarking Process Maturity</td>
<td>W.N. Crowder, M.J. Carr</td>
<td>661</td>
</tr>
<tr>
<td></td>
<td>Systems Engineering Framework for Deploying eCommerce Websites</td>
<td>B. Shah</td>
<td>669</td>
</tr>
</tbody>
</table>
### Analysis 2

**5.5.1 The Shangri-La of ROI**  
*S. Sheard, C.L. Miller* .................................................. 685

**5.5.2 The Effectiveness of Multiple Software Requirements Elicitation Methods - A Case Study**  
*S. White, R.M. Gonzales, E. Johnson* .................................................. 693

**5.5.3 Supportability Assessment and Evaluation During System Architecture Development**  
*L.H. Johannesen, D. Verma* .................................................. 699

**5.5.4 Legacy System Evolution to an Enterprise-Wide Architecture Framework**  
*Y. Lacerte* .................................................. 707

### Process 1

**7.5.1 The House of IPD - Integrating the WHY's, WHAT's and HOW's for Successful Systems Development**  
*S. Wenzel, H. Negel, E. Fricke* .................................................. 713

**7.5.2 What the Lessons Learned from Large, Complex, Technical Projects Tell Us About the Art of Systems Engineering**  
*S.C. Cook* .................................................. 723

**7.5.3 An Application of the CEaVa Method**  
*B. Larsen, D.M. Buede* .................................................. 731

**7.5.4 International Space Station Integrated Verification Process**  
*B.R. Haskins* .................................................. 739

### SECTION VI: EDUCATION/STANDARDS

#### Education and Research 1

**1.6.1 Development of Systems Engineers: A Structured Approach Based Upon International Experience**  
*M.B. Harris* .................................................. 749

**1.6.2 Electronic Systems Engineering (E-SE): Exploiting Internet Technology -or- a Project Portal Primer**  
*L.D. Pohlmann* .................................................. 757

**1.6.3 Cognitive and Personality Characteristics of Successful Systems Engineers**  
*M. Frank* .................................................. 765

**1.6.4 Systems Engineering is Not Just Engineering - Or is it? A Critical Look at the Scope of our Profession**  
*J.N. Martin* .................................................. 775

#### Education and Research 2

**2.6.1 Germany's V-2 Rocket Program and the Application of Systems Engineering**  
*T.S. Ankrum* .................................................. 783

**2.6.2 An Approach to Develop a Systems Engineering Curriculum For Human Capital and Process Improvement**  
*G.D. Burke, M.J. Harrison, R.E. Fenton, P.G. Carlock* .................................................. 791

**2.6.3 Designing a Systems Engineering Educational Program Using Academic/Industry Collaboration**  

**2.6.4 Creativity and Innovation in the Systems Engineering Process**  
*D.H. Cropley, A.J. Cropley* .................................................. 807

#### Standards 2

**5.6.1 AP-233 Architecture**  
*E. Herzog, A. Törne* .................................................. 815

**5.6.2 The Maturing Systems Engineering Data Exchange Standard AP-233 & Your Role**  
*J. Johnson, S. Barbeau, E. Herzog, M. Giblin* .................................................. 823
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.6.3</td>
<td>Integrating Systems and Software Engineering Concepts in AP-233</td>
<td>A. Pandikow, E. Herzog, A. Törne</td>
<td>831</td>
</tr>
<tr>
<td>5.6.4</td>
<td>An International Standard for the Description of Systems - The Telecommunication World Has One</td>
<td>R. Kaffenberger</td>
<td>839</td>
</tr>
<tr>
<td></td>
<td><strong>Standards 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.6.1</td>
<td>Systems Engineering: From Process Toward Profession</td>
<td>S. Arnold</td>
<td>847</td>
</tr>
<tr>
<td>6.6.3</td>
<td>Testing - Let Me Count the Ways: Taguchi Versus Combinatorial Design</td>
<td>J. Huller</td>
<td>867</td>
</tr>
<tr>
<td>6.6.4</td>
<td>Case Study in Effective Government - Contractor Partnering</td>
<td>J.A. Thornton, H.A. Kinsinger, M.A. Luczak</td>
<td>875</td>
</tr>
<tr>
<td></td>
<td><strong>Commercial Aviation Applications 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.6.2</td>
<td>Systems Engineering - Consumer and Infrastructure Approaches</td>
<td>M. Kayton, R. Ogan</td>
<td>891</td>
</tr>
<tr>
<td>8.6.4</td>
<td>Denver International Airport: How Could Systems Engineering Principles Have Prevented Disaster?</td>
<td>R.H. Cook</td>
<td>903</td>
</tr>
<tr>
<td></td>
<td><strong>SECTION VII: SUPPLEMENTAL PAPERS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.1</td>
<td>Extending EIA-731 Systems Engineering Capability Model Appraisal Method for Safety and Tailoring the Method to Yellowstone National Park</td>
<td>S. Alessi, J.A. Johnesee, C.M. Plowman, N. Siler</td>
<td>911</td>
</tr>
<tr>
<td>9.2</td>
<td>Propulsion Control of Aircraft: A Case Study in Systems Engineering</td>
<td>R.A. Johnson</td>
<td>919</td>
</tr>
<tr>
<td>9.3</td>
<td>Teaming for Teaching: Producing Effective Systems Engineers for the 21st Century</td>
<td>J. Kasser</td>
<td>927</td>
</tr>
<tr>
<td>9.4</td>
<td>The Role of Configuration Management in Earned Value Management</td>
<td>K.G. Kehoe, W.H. McCumber, Jr.</td>
<td>931</td>
</tr>
<tr>
<td>9.5</td>
<td>A Systems Comparison of Public Perception and Policy Towards Genetic Engineering in the EU and the US</td>
<td>F. Kraus, H. Negele, P.L. Bereano</td>
<td>939</td>
</tr>
<tr>
<td>9.6</td>
<td>Meta-Systems Engineering</td>
<td>K.D. Palmer</td>
<td>947</td>
</tr>
<tr>
<td>9.7</td>
<td>Overview of a CONOPS for an SE Education Community</td>
<td>J. Ring, A.W. Wymore</td>
<td>963</td>
</tr>
</tbody>
</table>
SECTION VIII: PANELS, TUTORIALS, ACADEMIC FORUM ..................

SECTION IX:  AUTHOR INDEX ............................................ 985

TITLE INDEX .......................................................... 989