Prologue xiii
Preface xv
Acknowledgments xix

CHAPTER 1
Introduction 1
1.1 Introduction 1
1.2 Myopic View 2
   1.2.1 Case Example 3
1.3 Enterprise Visibility 4
1.4 Game Theory 6
   1.4.1 Case Study: Game Theory 8
1.5 First Steps 8
1.6 Summary 9
References 11
Additional Reading 11

CHAPTER 2
Augmented Reality 13
2.1 Introduction 13
2.2 Time to Market 15
2.3 Complexity 16
2.4 New Design Intervals 17
2.5 Augmented Reality 17
2.6 Extension to Manufacturing 19
   2.6.1 The Process for Automation 20
   2.6.2 New Tools 20
   2.6.3 The Highly Immersive Virtual Environment (HIVE) 21
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.4.5 Deflection</td>
<td>55</td>
</tr>
<tr>
<td>4.4.6 Control</td>
<td>55</td>
</tr>
<tr>
<td>4.5 The Cyber Security Conundrum</td>
<td>56</td>
</tr>
<tr>
<td>4.6 Mitigating Cyber and Physical Threats to Security</td>
<td>56</td>
</tr>
<tr>
<td>4.7 Summary</td>
<td>58</td>
</tr>
<tr>
<td>References</td>
<td>58</td>
</tr>
</tbody>
</table>

## CHAPTER 5

### Automation

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 Introduction</td>
<td>61</td>
</tr>
<tr>
<td>5.2 What Is Automation?</td>
<td>68</td>
</tr>
<tr>
<td>5.3 Trusting the System and Risk</td>
<td>69</td>
</tr>
<tr>
<td>5.4 Expert Systems</td>
<td>69</td>
</tr>
<tr>
<td>5.5 Types of Aerospace Automation</td>
<td>70</td>
</tr>
<tr>
<td>5.6 International Complications (Offset and Countertrade)</td>
<td>73</td>
</tr>
<tr>
<td>5.7 Flex to Rate (Flexible Automation for Multiple Platforms)</td>
<td>73</td>
</tr>
<tr>
<td>5.8 Determinant Assembly</td>
<td>75</td>
</tr>
<tr>
<td>5.9 Engineering Release</td>
<td>76</td>
</tr>
<tr>
<td>5.10 ROI</td>
<td>77</td>
</tr>
<tr>
<td>5.11 Collision</td>
<td>79</td>
</tr>
<tr>
<td>5.12 Automation versus Mechanization</td>
<td>79</td>
</tr>
<tr>
<td>5.13 Variability (Taming the Beast)</td>
<td>81</td>
</tr>
<tr>
<td>5.14 Case Example: Jewels on the Ground</td>
<td>81</td>
</tr>
<tr>
<td>5.15 Evolution of Specialized Suppliers</td>
<td>82</td>
</tr>
<tr>
<td>5.15.1 Limited Integrators Number of Integrators: Risk</td>
<td>83</td>
</tr>
<tr>
<td>5.15.2 Integrator Firewall Placement</td>
<td>83</td>
</tr>
<tr>
<td>5.15.3 Controlling Your Destiny</td>
<td>84</td>
</tr>
<tr>
<td>5.15.4 Coatings</td>
<td>84</td>
</tr>
<tr>
<td>5.16 Summary</td>
<td>85</td>
</tr>
<tr>
<td>5.16.1 Strengths</td>
<td>85</td>
</tr>
<tr>
<td>5.16.2 Weakness</td>
<td>85</td>
</tr>
<tr>
<td>5.16.3 Opportunities</td>
<td>85</td>
</tr>
<tr>
<td>5.16.4 Threats</td>
<td>85</td>
</tr>
<tr>
<td>5.17 One Future State Possibility</td>
<td>85</td>
</tr>
<tr>
<td>References</td>
<td>90</td>
</tr>
</tbody>
</table>
CHAPTER 6
Change

6.1 Introduction 91
6.2 Fear 93
6.3 Shop Floor to Top Floor 95
   6.3.1 Driving Change to the Top 96
6.4 Awareness 99
   6.4.1 Case Example: Oxford Mini 100
6.5 Demonstrating a Vision 102
6.6 Communicating Change (Top to Shop) 103
   6.6.1 Personalizing Change 103
6.7 Summary 104
One Final Note 105
6.8 Ten Questions to Ponder 105
   6.8.1 Definition of Terms 106
References 106

CHAPTER 7
Taming Variability

7.1 Introduction 107
7.2 Materials (Black Metal) 108
7.3 Variability Accommodation 109
7.4 Composite Material Genesis 110
   7.4.1 Controlling Fiber Distribution and Fuzzing 111
7.5 Compounding Variance (Unique Part DNA) 111
7.6 Spring-Back Control 113
   7.6.1 Dimension on Day-One: Future State 114
   7.6.2 Methodology 114
   7.6.3 Benefits 115
7.7 The Digital Twin 116
7.8 Summary 117
   Case Study: Automation and Variability 118
References 121
CHAPTER 8
Visibility

8.1 Introduction 123
8.2 Tactile Dexterity with Cognition 124
8.3 COBOTS 126
  8.3.1 Historical Background 127
  8.3.2 Need and Benefits 127
  8.3.3 Technical Concept for Development 128
  8.3.4 Execution Approach 130
  8.3.5 Conclusion 131
8.4 RFID 131
  8.4.1 Basics 131
  8.4.2 Security 136
8.5 Digital Twin 138
8.6 Global Enterprise Visibility 139
  8.6.1 Empowering the Organization 142
8.7 Summary 142
8.8 Case Example: RFID for Chemical Tracking and Hazardous Waste Management 143
References 144

CHAPTER 9
Lessons from the Field 145

9.1 Introduction 145
9.2 Case Example 146
9.3 Further Sensitivity 147
9.4 Automation 149
9.5 Data Mining 149
9.6 Variability 150
9.7 Visibility 150
9.8 Restructuring the Enterprise Image 151
9.9 Some Final Thoughts 152
  9.9.1 Design for Manufacture and Affordability 152
  9.9.2 Brand Loyalty and Association 153