Contents

1 Introduction ................................................................. 1
  1.1 What Is This Book About? ........................................... 1
  1.2 Offering Technological Response to World Challenges ....... 1
  1.3 Background and History ............................................. 2
    1.3.1 Creating Distributed Networks ............................... 2
    1.3.2 Using Program Mobility ....................................... 2
    1.3.3 Active Graphs and Networks .................................. 3
    1.3.4 Mobile Programs in Active Networks ....................... 3
    1.3.5 International Support ......................................... 4
  1.4 The Book Organization .............................................. 5
References ................................................................. 8

2 Some Theoretical Background ............................................. 11
  2.1 Introduction ......................................................... 11
  2.2 General Systems Theory ........................................... 11
  2.3 System Dynamics ................................................... 13
  2.4 Gestalt Psychology ................................................ 15
  2.5 Memetics Versus Genetics ......................................... 20
  2.6 Brain Waves and Consciousness .................................. 21
  2.7 Interoperability Organizations and Their Weakness .......... 23
  2.8 Over-Operability Versus Interoperability in System
    Organization ....................................................... 25
  2.9 Conclusion ........................................................ 28
References ................................................................. 28

3 Spatial Grasp Model ..................................................... 31
  3.1 Introduction ......................................................... 31
  3.2 Spatial Grasp Model Key Issues .................................. 32
    3.2.1 General Idea ................................................. 32
    3.2.2 Parallel Wavelike World Coverage ......................... 32
3.2.3 Navigation Pattern’s Modification, Reduction, and Replication ........................................ 33
3.2.4 Spatial Grasp with Echo Processing ........................................ 33
3.2.5 Multisource Matching ........................................ 35
3.2.6 Combining Biological, Sociological, and Psychological Ideas ........................................ 36
3.3 General Organization of Spatial Grasp Language, SGL ........................................ 36
3.3.1 SGL Orientation and Peculiarities ........................................ 36
3.3.2 SGL Recursive Structure ........................................ 37
3.3.3 Constants ........................................ 37
3.3.4 Variables ........................................ 38
3.3.5 Rules ........................................ 38
3.4 More SGL Details ........................................ 38
3.4.1 SGL Worlds ........................................ 39
3.4.2 How SGL Scenarios Evolve ........................................ 39
3.4.3 Sense and Nature of SGL Rules ........................................ 40
3.4.4 The Use of SGL Variables ........................................ 41
3.4.5 SGL Control States and Their Hierarchical Merge ........................................ 42
3.5 Elementary Examples in SGL ........................................ 43
3.6 General Issues of SGL Networked Interpretation ........................................ 52
3.7 Conclusion ........................................ 53

References ........................................ 54

4 SGL Detailed Specification ........................................ 57
4.1 Introduction ........................................ 57
4.2 Full SGL Syntax and Main Constructs ........................................ 57
4.3 SGL Constants ........................................ 60
4.3.1 Information ........................................ 60
4.3.2 Physical Matter ........................................ 60
4.3.3 Custom Constants ........................................ 61
4.3.4 Special Constants ........................................ 61
4.3.5 Compound Constants, Grasps ........................................ 62
4.4 SGL Variables ........................................ 62
4.4.1 Global, Heritable, Frontal, and Nodal Variables ........................................ 62
4.4.2 Environmental Variables ........................................ 62
4.5 SGL Rules ........................................ 66
4.5.1 Movement ........................................ 66
4.5.2 Creation ........................................ 67
4.5.3 Echoing ........................................ 68
4.5.4 Verification ........................................ 70
4.5.5 Assignment ........................................ 70
4.5.6 Advancement ........................................ 71
4.5.7 Branching ........................................ 72
4.5.8 Transference ........................................ 75
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3.9</td>
<td>Nodal Variables</td>
</tr>
<tr>
<td>6.3.10</td>
<td>Environmental Variables</td>
</tr>
<tr>
<td>6.3.11</td>
<td>Global Variables</td>
</tr>
<tr>
<td>6.3.12</td>
<td>Incoming Queue</td>
</tr>
<tr>
<td>6.3.13</td>
<td>Outgoing Queue</td>
</tr>
<tr>
<td>6.4</td>
<td>Functional Processors</td>
</tr>
<tr>
<td>6.4.1</td>
<td>Communication Processor</td>
</tr>
<tr>
<td>6.4.2</td>
<td>Parser</td>
</tr>
<tr>
<td>6.4.3</td>
<td>Operation Processors</td>
</tr>
<tr>
<td>6.4.4</td>
<td>Navigation Processor</td>
</tr>
<tr>
<td>6.4.5</td>
<td>Control Processor</td>
</tr>
<tr>
<td>6.4.6</td>
<td>World Access Unit</td>
</tr>
<tr>
<td>6.5</td>
<td>Track-Based Automatic Command and Control</td>
</tr>
<tr>
<td>6.5.1</td>
<td>Track-Based Management Components</td>
</tr>
<tr>
<td>6.5.2</td>
<td>Forward Grasping</td>
</tr>
<tr>
<td>6.5.3</td>
<td>Distribution of Track Structure</td>
</tr>
<tr>
<td>6.5.4</td>
<td>Echoing Via Tracks</td>
</tr>
<tr>
<td>6.5.5</td>
<td>Failed and Blocked Track Branches</td>
</tr>
<tr>
<td>6.5.6</td>
<td>Further World Grasping</td>
</tr>
<tr>
<td>6.5.7</td>
<td>More Advanced Track Infrastructure</td>
</tr>
<tr>
<td>6.6</td>
<td>Examples of Involvement of Interpreter Components</td>
</tr>
<tr>
<td>6.6.1</td>
<td>Transferring Control Messages</td>
</tr>
<tr>
<td>6.6.2</td>
<td>Engagement in Data Processing</td>
</tr>
<tr>
<td>6.6.3</td>
<td>Networked Knowledge Processing</td>
</tr>
<tr>
<td>6.6.4</td>
<td>Movement in Physical Space</td>
</tr>
<tr>
<td>6.7</td>
<td>Integration with Other Systems</td>
</tr>
<tr>
<td>6.8</td>
<td>Conclusions</td>
</tr>
<tr>
<td>References</td>
<td></td>
</tr>
</tbody>
</table>

**7 Creation, Activation, and Management of a Distributed World**

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Introduction</td>
</tr>
<tr>
<td>7.2</td>
<td>Distributed World Creation</td>
</tr>
<tr>
<td>7.2.1</td>
<td>Elementary Examples</td>
</tr>
<tr>
<td>7.2.2</td>
<td>Creating General Networks</td>
</tr>
<tr>
<td>7.3</td>
<td>Network Distribution</td>
</tr>
<tr>
<td>7.4</td>
<td>World’s Invasion with Mobile Objects</td>
</tr>
<tr>
<td>7.5</td>
<td>Collecting and Exhibiting the History of Navigation</td>
</tr>
<tr>
<td>7.6</td>
<td>Adding Nodal Activity</td>
</tr>
<tr>
<td>7.7</td>
<td>Global Supervision and Inspection</td>
</tr>
<tr>
<td>7.8</td>
<td>Runtime Restructuring of the Active Distributed World</td>
</tr>
</tbody>
</table>
8 Parallel and Distributed Network Operations .......................... 159
  8.1 Introduction ....................................... 159
  8.2 Finding Simple Paths Between Nodes ....................... 160
    8.2.1 All Simple Paths ................................ 160
    8.2.2 Limited Length Simple Paths ...................... 161
    8.2.3 Using Constraints on Links ....................... 161
    8.2.4 Constraints on Both Links and Nodes ............... 162
    8.2.5 Taking into Account Orientation of Links ........... 162
    8.2.6 Issuing the Paths in the Final Node ................. 163
  8.3 Creating Shortest Path Tree ............................... 163
  8.4 Finding Shortest Path Between Nodes ........................ 164
    8.4.1 Single Source Solution .......................... 164
    8.4.2 Two-Source Solution ............................ 165
  8.5 Moving Physical Matter via the Path Found ................. 166
    8.5.1 Matter Moving Along the Path ...................... 167
    8.5.2 Matter Moving Opposite the Path ................... 167
  8.6 Finding Weak and Strong Components in Networks .......... 168
    8.6.1 Finding Weakest Points .......................... 168
    8.6.2 Finding Strongest Parts .......................... 170
  8.7 Finding Arbitrary Structures in Arbitrary Networks ....... 172
    8.7.1 Exemplary Network and Search Template .............. 172
    8.7.2 Template Representation Based 
on a Path Through All Nodes ....................... 172
    8.7.3 Template Representation Based on a Path 
Through All Links .................................. 174
    8.7.4 Networks with Named Nodes and Links ............... 175
    8.7.5 Working with Networks Having Multiple Links 
Between Nodes ...................................... 177
  8.8 Examples of Finding Particular Structures .................. 177
    8.8.1 Example 1: Triangle .............................. 178
    8.8.2 Example 2: Two Triangles Sharing a Side ............ 179
    8.8.3 Example 3: Unlimited Expanding Structure ............ 180
  8.9 Conclusion .......................................... 181
References ................................................ 181
9 Solving Societal Problems ........................................ 183
  9.1 Introduction ............................................. 183
  9.2 Social Problems and Social Networks ....................... 184
    9.2.1 Social Problems Examples ......................... 184
    9.2.2 Human Terrain Concept and Its Relation to Social
          Problems ....................................... 184
    9.2.3 Social Networks and Their Representation .......... 186
  9.3 Exemplary Social Network Operations ....................... 187
    9.3.1 Distributed Counting of the Number of Nodes
          and Links ....................................... 187
    9.3.2 Finding Paths Between Nodes........................ 188
    9.3.3 Shortest Path Tree and Solutions Based on It ....... 191
    9.3.4 Spatial Centres of Organizations .................. 195
  9.4 Active and Assisted Living ................................ 198
  9.5 Emergency Management ..................................... 200
    9.5.1 Investigating and Relieving Disaster
          Consequences .................................. 200
    9.5.2 Collective Evacuation from a Disaster Zone ......... 201
  9.6 Other Societal Tasks Currently Investigated Under SGT .... 202
  9.7 Conclusion ............................................. 203
References .................................................... 203

10 Automated Command and Control ............................ 205
  10.1 Introduction ........................................... 205
  10.2 Purely Semantic Scenario with Automatic Control ......... 206
    10.2.1 Exemplary Task .................................. 206
    10.2.2 Three-Doer Task Solution ......................... 207
    10.2.3 Task Solution with Other Numbers of Doers ....... 212
  10.3 Dynamic Creation of Distributed Command Infrastructures .. 213
    10.3.1 Hierarchical Operational Infrastructure ........... 214
    10.3.2 Peripheral, Ring Infrastructure .................. 218
  10.4 Withstanding Cruise Missiles ............................ 220
    10.4.1 Existing Solutions ............................... 220
    10.4.2 Installing SGL Interpreters in Distributed Sensors 221
    10.4.3 Distributed Missile Tracking Scenario in SGL .... 222
    10.4.4 Withstanding Multiple Attacks .................... 224
  10.5 Networked Night Vision Scenarios ......................... 226
    10.5.1 Multiple Spatial Vision of a Particular Object .... 226
    10.5.2 Multiple Spatial Vision of the Whole Theatre .... 228
  10.6 Europe-Related Missile Defense Scenario ................ 229
    10.6.1 Missile Defense Main Stages ...................... 229
    10.6.2 Missile Defense Management in SGL ................ 232
10.7 High-Level Battle Management in SGL ................. 233
10.7.1 Traditional Battle Management in BML ............. 233
10.7.2 Same Management Scenario in SGL .................. 235
10.8 Distributed Avionics .................................. 237
10.9 Conclusion ........................................ 238
References ............................................. 239

11 Collective Robotics ..................................... 241
11.1 Introduction ....................................... 241
11.2 Some Modern Robotic Examples ....................... 242
11.2.1 Ground Robotics ................................ 242
11.2.2 Aerial Robotics ................................ 242
11.2.3 Maritime Robotics .............................. 243
11.2.4 Collectively Behaving Robots .................... 244
11.2.5 General Demands to Advanced Robotic Systems ... 245
11.3 Integration of Loose Swarming with Hierarchical Command and Control ........................................ 246
11.4 Multi-robot Hospital Service Example ................... 250
11.5 Exploration and Mapping of Unknown Distributed Space .... 252
11.5.1 Different Mapping Scenarios .................... 253
11.5.2 Finding Optimal Route by the Created Free Space Grid ................................................. 256
11.6 Battling Forest Fires with Robotic Swarms .......... 257
11.7 Coastal Waters Cooperative Patrol .................... 259
11.8 Cooperative Finding of Oil Spill Center ............... 261
11.9 Maritime Massive Robotic Attack ..................... 263
11.10 Swarm Against Swarm Aerial Scenario ............... 265
11.11 Cooperative Robotic Forestry and Agriculture ......... 266
11.12 Conclusion ........................................ 272
References ............................................. 272

12 Conclusions ........................................... 275
12.1 General Advantages of the Technology Developed .... 275
12.2 Contribution to the System Theory and Practice ...... 275
12.3 Some Particular Application Areas .................... 279
12.4 Implementation Issues and Future Plans ............... 282
References ............................................. 282
Managing Distributed Dynamic Systems with Spatial Grasp Technology
Sapaty, P.S.
2017, XVII, 284 p. 215 illus., 167 illus. in color., Hardcover
ISBN: 978-3-319-50459-9