

# Contents

|                               |  |           |
|-------------------------------|--|-----------|
| <b>1</b>                      | <b>Introduction</b>                                    | <b>1</b>  |
| 1.1                           | Road Map   | 1         |
| 1.2                           | Origin of the Book and Acknowledgments                 | 3         |
| <br><b>Part I Contracting</b> |  |           |
| <b>2</b>                      | <b>Multiple-Project Management</b>                     | <b>7</b>  |
| 2.1                           | The Multiple-Project Environment                       | 7         |
| 2.2                           | Project Portfolio Management                           | 8         |
| 2.3                           | Program Management                                     | 8         |
| 2.3.1                         | Notion of Program Management                           | 8         |
| 2.3.2                         | Grouping Projects                                      | 9         |
| 2.3.3                         | Defining Programs: Selecting and Prioritizing Projects | 10        |
| 2.3.4                         | Developing Programs                                    | 12        |
|                               | References and Additional Resources                    | 13        |
| <b>3</b>                      | <b>Contract Organization</b>                           | <b>15</b> |
| 3.1                           | Roles in Construction Projects                         | 15        |
| 3.2                           | Notion of Contracting                                  | 16        |
| 3.3                           | Delivery Systems                                       | 17        |
| 3.3.1                         | Design-Bid-Build                                       | 18        |
| 3.3.2                         | Construction Manager                                   | 20        |
| 3.3.3                         | Design-Build   | 22        |
| 3.3.4                         | Turnkey  | 23        |
| 3.3.5                         | Build-Operate-Transfer                                 | 24        |
| 3.3.6                         | Summary of Delivery Systems                            | 24        |
| 3.4                           | Payment Schemes  | 25        |
| 3.4.1                         | Time and Material                                      | 27        |
| 3.4.2                         | Unit Prices  | 28        |
| 3.4.3                         | Cost Plus Fixed Percentage Fee                         | 29        |
| 3.4.4                         | Cost Plus Incentive Fee                                | 31        |
| 3.4.5                         | Cost Plus Fixed Fee                                    | 31        |
| 3.4.6                         | Target Cost Plus Incentive Fixed Fee                   | 32        |

|                 |   |           |
|-----------------|---|-----------|
| 3.4.7           | Cost Plus an Award Fee . . . . .  | 34        |
| 3.4.8           | Guaranteed Maximum Price (GMP) . . . . .  | 34        |
| 3.4.9           | Firm Fixed Price . . . . .  | 36        |
| 3.4.10          | Summary of Payment Schemes . . . . .  | 37        |
| 3.5             | Award Methods . . . . .   | 38        |
| 3.6             | Selecting the Appropriate Contract Organization . . . . .                                       | 39        |
|                 | References and Additional Resources About Contract<br>Organization . . . . .                    | 42        |
| <b>4</b>        | <b>Contract Administration . . . . .</b>  | <b>43</b> |
| 4.1             | Introduction to Contract Administration . . . . .   | 43        |
| 4.2             | The Bid and Proposal Management Processes . . . . .   | 43        |
| 4.3             | The Contract Documents . . . . .  | 45        |
| 4.4             | Contract Bonds . . . . .  | 47        |
| 4.5             | Changes and Extra Work . . . . .  | 48        |
| 4.6             | Project Delays . . . . .  | 50        |
| 4.7             | Claims and Disputes . . . . .   | 50        |
| 4.8             | Project Close-Out . . . . .   | 52        |
|                 | References and Additional Resources About Contract<br>Administration . . . . .                  | 53        |
| <b>Part II</b>  | <b>Human Resources</b>  |           |
| <b>5</b>        | <b>Project Management Organization . . . . .</b>  | <b>57</b> |
| 5.1             | The Organizational Challenge . . . . .  | 57        |
| 5.2             | Organizing the Firm for Project Management . . . . .  | 58        |
| 5.3             | Organizing the Project Team . . . . .   | 62        |
| 5.4             | People and the Project Manager . . . . .  | 64        |
|                 | References and Additional Resources About Project<br>Management Organization . . . . .          | 66        |
| <b>6</b>        | <b>Project Information and Communications Management . . . . .</b>                              | <b>67</b> |
| 6.1             | Role of Information and Communications . . . . .  | 67        |
| 6.2             | Technologies and Systems for Project Management . . . . .                                       | 67        |
| 6.2.1           | Filing System . . . . .   | 68        |
| 6.2.2           | Individual Productivity Tools . . . . .   | 68        |
| 6.2.3           | Project Planning Tool . . . . .   | 68        |
| 6.2.4           | Collaborative Workplace . . . . .   | 69        |
| 6.3             | Communications Management . . . . .   | 69        |
|                 | References and Additional Resources About Information<br>and Communication Management . . . . . | 71        |
| <b>Part III</b> | <b>Money</b>  |           |
| <b>7</b>        | <b>Project Feasibility . . . . .</b>  | <b>75</b> |
| 7.1             | Project Financial Engineering . . . . .   | 75        |
| 7.1.1           | Owner Financing . . . . .   | 75        |

|                                       |  |            |
|---------------------------------------|--|------------|
| 7.1.2                                 | Project Financing . . . . .  | 79         |
| 7.1.3                                 | Contractor Financing . . . . .   | 79         |
| 7.2                                   | Financial Evaluation of Projects . . . . .   | 80         |
| 7.2.1                                 | Net Present Value . . . . .  | 81         |
| 7.2.2                                 | Choice of Discount Rate . . . . .  | 84         |
| 7.2.3                                 | IRR Versus NPV . . . . .   | 84         |
|                                       | References and Additional Resources About Feasibility . . . . .                      | 87         |
| <b>8</b>                              | <b>Planning and Scheduling . . . . .</b>   | <b>89</b>  |
| 8.1                                   | Project Planning: Breakdown Structuring . . . . .                                    | 89         |
| 8.1.1                                 | Work Breakdown Structure – “What” . . . . .  | 89         |
| 8.1.2                                 | Organizational Breakdown Structure – “Who” . . . . .                                 | 92         |
| 8.1.3                                 | Cost Breakdown Structure – “How Much” . . . . .                                      | 93         |
| 8.2                                   | Deterministic Scheduling Principles . . . . .  | 96         |
| 8.3                                   | Scheduling Systems . . . . .   | 97         |
| 8.3.1                                 | Matrix Scheduling . . . . .  | 98         |
| 8.3.2                                 | Gantt Chart Scheduling . . . . .   | 98         |
| 8.3.3                                 | Network Diagramming . . . . .  | 99         |
| 8.3.4                                 | Line-of-Balance Scheduling . . . . .   | 103        |
| 8.4                                   | Critical Path Method . . . . .   | 104        |
| 8.4.1                                 | Float Ownership . . . . .  | 108        |
| 8.5                                   | Precedence Diagramming Method . . . . .  | 109        |
| 8.6                                   | Resource-Based Scheduling . . . . .  | 110        |
| 8.6.1                                 | Time-Cost Schedule Optimization with CPM . . . . .                                   | 111        |
| 8.6.2                                 | Resource Leveling . . . . .  | 115        |
| 8.6.3                                 | Heuristic Scheduling Approaches . . . . .  | 116        |
|                                       | References and Additional Resources About Planning<br>and Scheduling . . . . .       | 117        |
| <b>9</b>                              | <b>Project Monitoring and Control . . . . .</b>                                      | <b>119</b> |
| 9.1                                   | The Monitoring Process . . . . .   | 119        |
| 9.2                                   | Measurement of Actual Progress . . . . .   | 119        |
| 9.3                                   | Performance Measurement: Earned Value Analysis . . . . .                             | 124        |
| 9.4                                   | Forecasting Performance . . . . .  | 129        |
| 9.5                                   | Project Reporting . . . . .  | 133        |
| 9.6                                   | Areas of Project Control . . . . .   | 134        |
|                                       | References and Additional Resources About Project<br>Monitoring & Control . . . . .  | 136        |
| <br><b>Part IV Material Resources</b> |  |            |
| <b>10</b>                             | <b>Procurement Management . . . . .</b>  | <b>141</b> |
| 10.1                                  | Introduction to Procurement Management . . . . .                                     | 141        |
| 10.2                                  | Procurement Methods and Strategies for Managing<br>the Construction Supply . . . . . | 141        |

|               |   |            |
|---------------|---|------------|
| 10.3          | The Procurement Process . . . . .   | 143        |
|               | References and Additional Resources About Procurement<br>Management . . . . .   | 145        |
| <b>11</b>     | <b>Site Management . . . . .</b>  | <b>147</b> |
| 11.1          | Management of Construction Equipment . . . . .                                  | 147        |
| 11.2          | Quality Management . . . . .  | 148        |
| 11.3          | Site Operations and Safety . . . . .  | 149        |
|               | References and Additional Resources About Site Management . . . .               | 150        |
| <b>Part V</b> | <b>Uncertainty</b>  |            |
| <b>12</b>     | <b>Decision Making . . . . .</b>  | <b>153</b> |
| 12.1          | Introduction . . . . .  | 153        |
| 12.2          | Decision Analysis . . . . .   | 153        |
| 12.2.1        | Decision Trees . . . . .  | 154        |
| 12.2.2        | Expected Value . . . . .  | 155        |
| 12.2.3        | Utility Function . . . . .  | 156        |
| 12.2.4        | Notion of Risk Premium . . . . .  | 157        |
| 12.3          | Multiple-Attribute Decision Making . . . . .                                    | 159        |
| 12.4          | Monte Carlo Simulation . . . . .  | 161        |
|               | References and Additional Resources About Decision Making . . . .               | 161        |
| <b>13</b>     | <b>Probabilistic Scheduling . . . . .</b>                                       | <b>163</b> |
| 13.1          | Scheduling with Uncertainty . . . . .   | 163        |
| 13.2          | Pert . . . . .  | 163        |
| 13.3          | Simulations . . . . .   | 170        |
| 13.3.1        | Monte Carlo Simulations . . . . .   | 170        |
| 13.3.2        | GERT . . . . .  | 173        |
|               | References and Additional Resources About Probabilistic<br>Scheduling . . . . . | 174        |
| <b>14</b>     | <b>Risk Management . . . . .</b>  | <b>175</b> |
| 14.1          | Risk Identification . . . . .   | 175        |
| 14.2          | Risk Breakdown Structure . . . . .  | 177        |
| 14.3          | Risk Quantification . . . . .   | 177        |
| 14.4          | Risk Control . . . . .  | 181        |
|               | References and Additional Resources About Risk Management . . . .               | 182        |
|               | <b>Abbreviations and Acronyms . . . . .</b>                                     | <b>185</b> |
|               | <b>Index . . . . .</b>  | <b>187</b> |



<http://www.springer.com/978-3-642-17091-1>

Project Management for Facility Constructions

A Guide for Engineers and Architects

De Marco, A.

2011, VIII, 189 p., Hardcover

ISBN: 978-3-642-17091-1