

Configuration Management

Theory, Practice, and Application



Jon M. Quigley and Kim L. Robertson

 **CRC Press**
Taylor & Francis Group
AN AUERBACH BOOK

Contents

List of Figures	xvii
Preface.....	xxi
Acknowledgments	xxiii
Authors.....	xxv

SECTION I DEFINE THE BASIS OF TERMS AND THEIR CONTEXT

1 Overview of the Product Life Cycle.....	3
1.1 Questions to Ponder	3
1.2 Introduction	3
1.3 Phases.....	6
1.3.1 Development	6
1.3.2 Introduction	7
1.3.3 Growth.....	8
1.3.4 Maturity.....	9
1.3.5 Decline.....	10
1.3.6 After the Decline.....	10
1.4 CM and the Dynamics of Change.....	10
1.4.1 Survivability Conditions.....	13
1.4.1.1 Nature	14
1.4.1.2 Products	14
1.4.2 Evolution of the Horseless Carriage.....	15
1.4.2.1 A Look at the Converging Technologies	15
1.4.3 Product Market Adaptation.....	19
1.4.4 Product Performance Adaptation.....	21
1.5 CM and Market Adaptations.....	23
1.5.1 Mass Customization	23
1.5.2 Performance Adaptations.....	26
1.5.2.1 Adaptive Radiation.....	27
1.5.2.2 New Drawing versus New Dash Number.....	31
1.5.2.3 Design Reuse versus Common Design	39

1.6	Case Studies	45
1.6.1	Case 1—Product Market Adaptation versus Performance Adaptation	45
1.6.2	Case 2—Share Design Decision	45
2	Overview of the Supporting Enterprise Infrastructure	49
2.1	Questions to Ponder	49
2.2	Introduction	50
2.3	Information Technology	51
2.3.1	A Brief History of Information and Information Security	52
2.3.1.1	Examples of Capability Demand	59
2.3.1.2	Examples of Capacity Demand	60
2.3.2	Stability of Internal Infrastructure	61
2.3.2.1	IT Backbone	63
2.3.2.2	Application Deployment	67
2.3.2.3	IT System Security	76
2.3.2.4	Platform Transitions	80
2.3.2.5	Importance of CM with Modular Systems	81
2.3.2.6	IT Case Studies	84
2.4	Overhead, General and Administrative, and Other Cost Elements	88
2.5	Intellectual Property	94
2.5.1	What Is IP?	95
2.5.2	What Drives IP?	95
2.5.2.1	Internal	95
2.5.2.2	External	96
2.5.3	How It Applies to CM	97
2.5.4	Why Is It Necessary?	98
2.5.5	IP and Legal Documentation (Incarnations or Permutations of the Design)	98
2.6	International Traffic in Arms Regulations	99
2.6.1	Counterfeit Products Circa 800	101
3	Functional Resources	103
3.1	Questions to Ponder	103
3.2	Introduction	103
3.3	Project Management	104
3.3.1	Project Integration Management	104
3.3.2	Scope Management	105
3.3.3	Time Management	106
3.3.4	Project Communications Management	107
3.3.4.1	Information Distribution	107
3.3.4.2	Information Description	107
3.3.4.3	Information Schedule	107
3.3.4.4	Progress Reporting	108
3.3.4.5	Communications Plan Revision	108
3.3.4.6	Escalation Process	108
3.3.4.7	Administrative Closure	108

3.3.5	Project Cost Management (Earned Value Management)	108
3.3.5.1	Schedule Performance Index	109
3.3.5.2	Cost Performance	109
3.3.5.3	Schedule Variance	109
3.3.5.4	Cost Variance	109
3.3.6	Project Quality Management	109
3.3.7	Project Risk Management	110
3.3.8	Action Item List	110
3.4	Engineering	111
3.4.1	Design and Requirements	112
3.4.2	Simulation and Verification	115
3.4.3	Bills of Materials and Bills of Documentation	115
3.5	Production	116
3.5.1	Production Setup	117
3.5.2	Production Test and Verification	117
3.6	Finance	118
3.7	Legal	119
3.8	Contracts Department	119
3.9	Supply Chain Management	121
3.10	Facilities	121
3.10.1	Property Management	122
4	Configuration Management and Product Management	123
4.1	Questions to Ponder	123
4.2	Introduction	123
4.3	Marketing	123
4.3.1	Product	125
4.3.2	Price	125
4.3.3	Promotion	126
4.3.4	Place	126
4.3.5	Marketing and Market Research	127
4.3.6	Customer Interface	127
4.3.7	Market Segmentation	128
4.4	Increasing the Complexity of the Product	128
4.4.1	Embedded Software	128
4.4.1.1	Embedded Firmware	129
4.4.1.2	Physical Attributes of Software Not Visible	129
4.4.1.3	Capabilities of Software Not Externally Obvious	129
4.4.2	Embedded Hardware	130
4.4.2.1	Embedded Hardware Attributes Not Readily Visible	130
4.4.2.2	Capabilities of Hardware Not Obvious through Implied	130
4.4.3	System Complexity	130
4.5	Distributed Product Development	131
4.5.1	Outsourced Coordinated Development	131

5	A Configuration Item and What It Implies.....	133
5.1	Questions to Ponder.....	134
5.2	Introduction.....	138
5.3	Serialization.....	140
5.4	Traceability.....	144
5.5	Higher Level of Management Controls.....	145
5.5.1	CM Planning.....	147
5.5.2	Configuration Identification.....	153
5.5.3	Change Control.....	155
5.5.4	Configuration Status Accounting.....	156
5.5.5	Configuration Audit.....	158
5.5.6	Metrics.....	
5.5.6.1	The Number of Engineering Drawings Released over Time—Poor Metric.....	158
5.5.6.2	The Engineering Orders Released against a Drawing—Poor Metric.....	159
5.5.6.3	The Number of CM and Software CM Requirements in the Contract—Good Metric.....	159
5.5.6.4	The How Long Engineering Orders Take to Be Approved and Released—Good Metric.....	160
6	Data Definition, Data Types, and Control Requirements.....	161
6.1	Questions to Ponder.....	161
6.2	Introduction.....	161
6.3	Data Definition.....	161
6.3.1	Knowledge Workers Spend 30% of Each Day Looking for Data with a 50% Success Rate.....	165
6.3.2	Data, if Found, Contains between 10% and 25% Data Inaccuracies.....	166
6.3.3	Lack of Data Cross-References and Coordination.....	167
6.3.4	Inadequate Data Definition Resulting in the Data Being Misinterpreted.....	168
6.3.5	Inadequate Data Safeguards.....	169
6.3.6	Multiple Sources of Truth for the Same Data.....	170
6.3.7	Too Much Data and Not Enough Intelligence.....	170
6.4	A Strict Data Diet.....	171
6.4.1	3D Printing.....	172
6.4.2	Quantum Computing.....	175
6.4.3	Database Transfers.....	176
6.4.4	Social Media, Real-Time Video/Images, and Text Messaging.....	176
6.4.4.1	Social Media.....	176
6.4.4.2	Real-Time Video and Other Images.....	178
6.4.4.3	Text Messaging.....	178
6.5	CM and Levels of Quality Business Systems Management.....	178
6.5.1	Level I, Policy Management.....	180
6.5.2	Level II, Plans Management.....	180
6.5.3	Level III, Process Management.....	180
6.5.4	Level IV, Procedures Management.....	181

6.5.5	Level V, Metadata Management	182
6.5.5.1	Configuration-Dependent Metadata Field Management	182
6.5.5.2	Nonconfiguration-Dependent Metadata Field Management ...	183
6.5.6	Level VI, Guidelines Management	183
6.5.7	Level I, II, III, and IV Requirements Management and CM Planning	184
7	Configuration Management	185
7.1	Questions to Ponder	185
7.2	Introduction	185
7.3	Overview of CM	188
7.3.1	History of CM	188
7.3.2	Das V-Modell	192
7.3.3	What Does CM Apply To?	193
7.3.3.1	Software Items	195
7.3.3.2	Firmware Items	195
7.3.3.3	Hardware Items	196
7.3.3.4	Drawings	196
7.3.3.5	Specifications	199
7.3.3.6	Material Lists	202
7.3.3.7	Document Material List (Document BOM)	203
7.3.3.8	Produced Item Material List (Item BOM)	204
7.3.3.9	Manufacturing Lines	204
7.3.4	CM Process Elements	212
7.3.4.1	Inputs	212
7.3.4.2	Constraints	213
7.3.4.3	Mechanisms/Facilitators	214
7.3.4.4	Outputs	214
7.3.5	Requirements and CM	214
7.3.5.1	Scope Trace through Requirements	214
7.3.5.2	Requirements and CM Overview	215
7.3.5.3	Success Criteria	219
7.3.5.4	Good versus Poor Requirements	221
7.3.5.5	Elicitation	224
7.3.5.6	Prioritizing and Tracking	228
7.3.5.7	Relationship between Requirements and CM	231
7.3.5.8	Logistics	232

SECTION II DEFINE THE INTERRELATIONSHIP OF CM TO FUNCTIONAL RESOURCES

8	Configuration Management Support of Functional Resources	237
8.1	Questions to Ponder	237
8.2	Introduction	237
8.3	CM and Project Management	238
8.3.1	Acceptance	238
8.3.2	DD Form-250 Use	238

8.3.3	CM and Project Integration Management.....	238
8.3.4	CM and Scope Management.....	239
8.3.5	CM and Time Management	240
8.3.6	CM and Project Communications Management.....	241
8.3.7	CM and Project Cost Management (Earned Value Management).....	241
8.3.7.1	Assumptions	241
8.3.7.2	Calculation of Cost Avoidance.....	242
8.3.7.3	Total Program Cost.....	242
8.3.7.4	Value to the External Customer	242
8.3.7.5	Value to the Company	243
8.3.8	CM and Project Quality Management.....	243
8.3.8.1	Protection from Audit	243
8.3.9	CM and Project Risk Management.....	243
8.3.10	CM and Action Item Lists	244
8.4	CM and Engineering.....	245
8.5	CM and Production	245
8.6	CM and Finance.....	245
8.7	CM and Legal	245
8.8	CM and Contracts Department	246
8.9	CM and Supply Chain Management.....	247
8.10	CM and Facilities	248
8.10.1	CM and Property Management	248
8.11	Time-Phased CM Activities.....	248
8.11.1	At Award.....	248
8.11.1.1	The Contract.....	248
8.11.1.2	Contract Provisions and Reference Documents.....	248
8.11.1.3	Hidden Data Submittal Requirements.....	249
8.11.1.4	Disconnects between Contract Parts or Documents	250
8.11.1.5	The Watch List.....	250
8.11.1.6	Contract Status Worksheet	251
8.11.1.7	Setting Up a Conformed Contract and Contractual Data Repository	252
8.11.2	Critical Noncontract-Related Activities.....	253
8.11.2.1	Findings, Tie Outs, and Next Actions	253
8.11.2.2	Resource Assessment and Management	254
8.11.2.3	IP Plan	257
8.11.2.4	DD Form-254 and "For Official Use Only" Marking	258
8.11.2.5	CM Plan	259
8.11.2.6	DRL Tracking System.....	260
8.11.2.7	DRL Cover Letters	262
8.11.2.8	Standardized Data Distributions Internal and External	262
8.11.2.9	The CCB.....	264
8.11.3	Hardware Quality Instruction and Software Quality Instruction	265
8.11.4	The Program Data Repository Basics	265
8.11.4.1	Program Intranet Site.....	265
8.11.4.2	Program Servers	267

	8.11.4.3 PD/LM Systems.....	269
	8.11.4.4 PD/LM Product Structure.....	270
8.12	The First 90 Days and Beyond.....	270
8.12.1	The 90/90 Rule.....	271
	8.12.1.1 Setting CM Expectations.....	271
8.12.2	Proposals and CM Budget.....	273
8.12.3	CM Interfaces.....	273
	8.12.3.1 Internal CM Interfaces.....	274
	8.12.3.2 Know Your Internal Customer.....	275
8.12.4	Program Do's and Don'ts.....	275
	8.12.4.1 CM as a Service Organization.....	277
8.12.5	The Many Faces of CM.....	277
	8.12.5.1 Presenting a Coordinated Face to the Customer.....	277
	8.12.5.2 Domestic ITAR Marking Inconsistencies.....	277
8.12.6	The Property Management Interface.....	277
	8.12.6.1 DD Form-250, Material Inspection and Receiving Report.....	278
8.12.7	DD-1149, Requisition and Invoice/Shipping Document.....	280
8.12.8	Shippers and DIL Deliveries.....	280
8.12.9	Certificates of Conformance.....	280
8.13	Summary.....	280

SECTION III DEFINING CURRENT PRACTICE

9	Configuration Management Baselines.....	285
9.1	Questions to Ponder.....	285
9.2	Introduction.....	285
9.3	There Are Many Baselines.....	291
	9.3.1 Functional.....	292
	9.3.2 Allocated.....	292
	9.3.3 Product.....	293
	9.3.4 Developmental.....	294
	9.3.4.1 Design Implications.....	294
	9.3.4.2 Change Implications.....	295
9.4	Triggers for Moving from One Baseline to the Next.....	295
	9.4.1 CM Implications of a Product Baseline.....	296
9.5	Baselines and Configuration Identification.....	297
	9.5.1 Phase-Based Item Re-Identification.....	298
9.6	Validation and Verification in Nongovernmental Sales.....	298
9.7	Product Acceptance.....	300
10	Configuration Control.....	301
10.1	Questions to Ponder.....	301
10.2	Management of a Configuration.....	301
10.3	CM Is a Management Tool.....	302

10.4	The CM Tower of Babel	306
10.4.1	Use Drives the CM Planning and Management Systems Design.....	308
10.4.1.1	Multiple Build End Items	308
10.4.2	Six Sigma.....	308
10.4.3	Multiple Build End Item and a Product Baseline.....	309
10.5	One-Off End Items	310
10.6	Management of Change	310
10.6.1	Engineering Change Request	311
10.6.2	Engineering Change Orders.....	311
10.6.2.1	Review Changes	314
10.6.2.2	Approval/Disapproval.....	319
10.7	Configuration Verification	319
10.7.1	Functional Aspect	319
10.7.1.1	Analysis	320
10.7.1.2	Inspection.....	320
10.7.1.3	Test.....	320
10.7.1.4	Demonstration	321
10.7.2	Aids to Functional Aspect Verification	321
10.7.2.1	CM and Test Execution Trials.....	322
10.7.2.2	Subsystems (Product Subelement) Verification	322
10.8	Systems (Product) Verification.....	322
10.8.1	Live Fire Exercise.....	323
10.8.2	Analysis, Inspection, Test, and Demonstration Master Plan.....	324
10.8.3	Requirements and Closure	324
10.9	Configuration Audit.....	324
10.9.1	In-Process Audits.....	324
10.9.2	Formal Audits	326
10.9.2.1	Functional Configuration Audit.....	327
10.9.2.2	Physical Configuration Audit	328
10.10	Material Receipt and Inspection.....	331
10.10.1	Goods.....	331
10.10.2	Production Material	331
10.10.3	Process Material	331
10.10.4	Customer-Furnished Material	331

SECTION IV WHEN THINGS GO WRONG

11	When Things Go Wrong!	335
11.1	Areas of Configuration Management Risk	335
11.2	Hardware and Software Integration	336
11.2.1	Commercial Titan—Intelsat 603	336
11.2.2	Koecmoc-3M—QuickBird 1	337
11.2.3	Items Delivered of Unknown Configuration	337
11.3	Ineffective ICWGs	337
11.3.1	Missile-X Interfaces	337
11.3.2	Mars Climate Orbiter.....	338

11.4	Milestone Slips because Metrics Were Not Used to Determine Where a Project Was	339
11.4.1	Throwing Decisions over the Fence	339
11.4.2	Company-Level Procedural Approval Holds Up Multiple Programs.....	339
11.5	Inordinate Change Processing Duration and Number of Changes	340
11.5.1	Low Temperature Microgravity Physics Facility	340
11.6	Lack of Change Implementation after Approval.....	341
11.6.1	Apollo 13 Oxygen Tanks.....	341
11.7	Lack of Control of Item Identification.....	342
11.7.1	General Motors Corporation Switch Recall.....	342
11.8	Undocumented Changes or Part Substitution in Final Product.....	343
11.8.1	Solar Maximum Mission.....	343
11.8.2	1978 BMW 320i w/Four Speed Getrag Gearbox Pilot Shaft Bearing	344
11.8.3	Drop-In Replacement Sometimes Not So	345
11.9	Lack of Proper Configuration Control Board Stakeholder Review	346
11.9.1	Harness Support Bracket Redesign w/o Harness Team Input.....	346
11.9.2	Small ICBM Internal Shelf Design.....	347
11.9.3	Informal Change Management	347
11.9.4	Open Loop and Stove Pipe Changes	348
11.10	High Rate of Scrap and Repair.....	348
11.10.1	Untested Item Substitution.....	348
11.11	Maintaining Software and Its Associated Design Documentation	349
11.11.1	Source Code and Compile.....	349
11.11.2	Merge Failure	349
11.12	Lack of Baseline Control	350
11.12.1	Subassembly of Switch.....	350
11.12.2	Insufficient Development Baseline Definitions.....	351
11.12.3	Lack of a CM-Managed Functional and Allocated Baseline.....	351
11.12.4	Design Baseline Updated from Wrong Revision.....	352
11.13	Inadequate Training of Those Performing CM Functions	352
11.13.1	What Is the Point of Processing an Engineering Order	352
11.13.2	Where Is That Written Down?	353
11.13.3	No Records to Combat Environmental Violation Allegations	353
11.13.4	Quotations	354

SECTION V TIEMPO, RELATED CM STANDARDS, AND REFERENCE DATA

12	Test, Inspection, and Evaluation Master Plan Organized.....	359
12.1	Philosophy of the Master Plan.....	360
12.2	Benefits of the Master Plan.....	360
12.3	An Overview of One Approach	360
12.4	System Definition.....	361
12.4.1	Test (Verification)	361
12.5	Reliability Testing	361

12.6	So, When Do We Start Testing?.....	362
12.6.1	Types of Tests during Development.....	362
12.7	Inspections	363
12.8	Evaluation (Validation)	363
12.9	Inspection Caveats	364
12.10	Product Development Phases	364
12.11	Conclusion	364
Appendix: Related Configuration Management Standards		367
Acronyms		387
Bibliography.....		391
Index		397
Value Transformation LLC		411