

Contents

<i>Preface</i>	xv
<i>Acknowledgments</i>	xxi
Part I	
What Is Automated Testing?	
1 The Birth and Evolution of Automated Testing	3
1.1 Automated Testing	3
1.2 Background on Software Testing	5
1.3 The Automated Test Life-Cycle Methodology (ATLM)	7
1.3.1 <i>Decision to Automate Test</i>	10
1.3.2 <i>Test Tool Acquisition</i>	12
1.3.3 <i>Automated Testing Introduction Phase</i>	12
1.3.4 <i>Test Planning, Design, and Development</i>	13
1.3.5 <i>Execution and Management of Tests</i>	14
1.3.6 <i>Test Program Review and Assessment</i>	14
1.4 ATLM's Role in the Software Testing Universe	14
1.4.1 <i>ATLM Relationship to System Development Life Cycle</i>	14
1.4.2 <i>Test Maturity Model (TMM)—Augmented by Automated Software Testing Maturity</i>	15
1.4.3 <i>Test Automation Development</i>	19
1.4.4 <i>Test Effort</i>	21
1.5 Software Testing Careers	22

2	Decision to Automate Test	29
2.1	Overcoming False Expectations for Automated Testing	32
2.1.1	<i>Automatic Test Plan Generation</i>	32
2.1.2	<i>Test Tool Fits All</i>	33
2.1.3	<i>Immediate Test Effort Reduction</i>	33
2.1.4	<i>Immediate Schedule Reduction</i>	34
2.1.5	<i>Tool Ease of Use</i>	34
2.1.6	<i>Universal Application of Test Automation</i>	35
2.1.7	<i>One Hundred Percent Test Coverage</i>	36
2.2	Benefits of Automated Testing	37
2.2.1	<i>Production of a Reliable System</i>	38
2.2.2	<i>Improvement of the Quality of the Test Effort</i>	43
2.2.3	<i>Reduction of Test Effort and Minimization of Schedule</i>	49
	<i>Case Study: Value of Test Automation Measurement</i>	52
2.3	Acquiring Management Support	54
2.3.1	<i>Test Tool Proposal</i>	56
3	Automated Test Tool Evaluation and Selection	67
3.1	The Organization's Systems Engineering Environment	70
3.1.1	<i>Third-Party Input from Management, Staff, and Customers and End Users</i>	71
3.1.2	<i>Tool Criteria Reflecting the Systems Engineering Environment</i>	72
3.1.3	<i>Level of Software Quality</i>	73
3.1.4	<i>Help Desk Problem Reports</i>	74
3.1.5	<i>Budget Constraints</i>	74
3.1.6	<i>Types of Tests</i>	74
3.1.7	<i>Long-Term Investment Considerations</i>	75
3.1.8	<i>Test Tool Process</i>	75
3.1.9	<i>Avoiding Shortcuts</i>	75
3.2	Tools That Support the Testing Life Cycle	76
3.2.1	<i>Business Analysis Phase Tools</i>	79
3.2.2	<i>Requirements Definition Phase Tools</i>	80
3.2.3	<i>Tools for the Analysis and Design Phase</i>	82
3.2.4	<i>Programming Phase Tools</i>	83
3.2.5	<i>Metrics Tools</i>	85
3.2.6	<i>Other Testing Life-Cycle Support Tools</i>	86
3.2.7	<i>Testing Phase Tools</i>	86

3.3	Test Tool Research	89
3.3.1	<i>Improvement Opportunities</i>	89
3.4	Evaluation Domain Definition	96
3.5	Hands-On Tool Evaluation	98
3.5.1	<i>Evaluation Report</i>	99
3.5.2	<i>License Agreement</i>	101
Part II		
Introduction of Automated Testing to a Project		
4	Automated Testing Introduction Process	107
4.1	Test Process Analysis	110
4.1.1	<i>Process Review</i>	112
4.1.2	<i>Goals and Objectives of Testing</i>	116
	<i>Case Study: Test Objectives and Strategies</i>	119
4.1.3	<i>Test Strategies</i>	120
4.2	Test Tool Consideration	133
4.2.1	<i>Review of Project-Specific System Requirements</i>	135
4.2.2	<i>Application-Under-Test Overview</i>	137
4.2.3	<i>Review of Project Schedule</i>	138
4.2.4	<i>Test Tool Compatibility Check</i>	139
4.2.5	<i>Demonstration of the Tool to the Project Team</i>	140
4.2.6	<i>Test Tool Support Profile</i>	141
4.2.7	<i>Review of Training Requirements</i>	143
5	Test Team Management	147
5.1	Organizational Structure of a Test Team	149
5.1.1	<i>Stovepipe Test Team</i>	151
5.1.2	<i>Centralized Test Team</i>	151
5.1.3	<i>IV&V Test Team</i>	153
5.1.4	<i>Systems Methodology and Test Team</i>	154
5.1.5	<i>Test Team Summary</i>	155
5.2	Test Program Tasks	157
5.3	Test Effort Sizing	163
5.3.1	<i>Test Team Sizing Methods: An Overview</i>	165
5.3.2	<i>Development Ratio Method</i>	165
5.3.3	<i>Percentage Method</i>	166
5.3.4	<i>Test Procedure Method</i>	167

5.3.5	<i>Task Planning Method</i>	168
5.3.6	<i>Test Effort Sizing Factors</i>	170
5.4	Test Engineer Recruiting	172
5.4.1	<i>Test Engineer Qualities</i>	172
5.4.2	<i>Test Team Composition</i>	174
5.4.3	<i>Job Requisition</i>	176
5.4.4	<i>Recruiting Activities</i>	178
5.4.5	<i>Locating Test Engineers</i>	178
5.4.6	<i>Test Engineer Interviews</i>	179
5.4.7	<i>Distinguishing the Best Candidate</i>	181
5.5	Roles and Responsibilities	182

Part III

Test Planning and Preparation

6	Test Planning: Smart Application of Testing	191
6.1	Test Planning Activities	192
6.2	Test Program Scope	197
6.2.1	<i>System Description</i>	198
6.2.2	<i>Critical/High-Risk Functions</i>	199
6.2.3	<i>Test Goals, Objectives, and Strategies</i>	199
6.2.4	<i>Test Tools</i>	199
6.2.5	<i>Test Program Parameters</i>	200
6.2.6	<i>Verification Methods</i>	202
6.2.7	<i>Test Requirements Definition</i>	203
6.3	Test Requirements Management	205
6.3.1	<i>Requirements Management Tools</i>	206
6.3.2	<i>Assessing the Test Requirements Risk</i>	208
6.3.3	<i>Prioritization of Tests</i>	208
6.3.4	<i>Requirements Traceability Matrix</i>	209
6.4	Test Program Events, Activities, and Documentation	211
6.4.1	<i>Events</i>	211
6.4.2	<i>Activities</i>	212
6.4.3	<i>Documentation</i>	213
6.5	The Test Environment	214
6.5.1	<i>Test Environment Preparations</i>	214
6.5.2	<i>Test Environment Integration and Setup</i>	216
6.6	The Test Plan	217

6.6.1	<i>Test Completion/Acceptance Criteria</i>	220
6.6.2	<i>Sample Test Plan</i>	220
7	Test Analysis and Design	223
7.1	Test Requirements Analysis	225
7.1.1	<i>Development-Level Test Analysis (Structural Approach)</i>	226
7.1.2	<i>System-Level Test Analysis (Behavioral Approach)</i>	228
7.2	Test Program Design	233
7.2.1	<i>Test Program Design Models</i>	233
7.2.2	<i>White-Box Techniques (Development-Level Tests)</i>	237
7.2.3	<i>Black-Box Techniques (System-Level Tests)</i>	244
7.2.4	<i>Test Design Documentation</i>	255
7.3	Test Procedure Design	256
7.3.1	<i>Test Procedure Definition</i>	257
7.3.2	<i>Automated Versus Manual Test Analysis</i>	262
7.3.3	<i>Automated Test Design Standards</i>	266
	<i>Case Study: Naming Conventions</i>	270
7.3.4	<i>Manual Test Design Guidelines</i>	272
7.3.5	<i>Detailed Test Design</i>	274
7.3.6	<i>Test Data Requirements</i>	277
8	Test Development	285
8.1	Test Development Architecture	288
8.1.1	<i>Technical Environment</i>	288
8.1.2	<i>Environment Readiness Checks</i>	291
8.1.3	<i>Automation Framework Reuse Analysis</i>	291
8.1.4	<i>Test Procedure Development/Execution Schedule</i>	292
8.1.5	<i>Modularity-Relationship Analysis</i>	295
8.1.6	<i>Explanation of the Sample Modularity- Relationship Matrix</i>	299
8.1.7	<i>Calibration of the Test Tool</i>	302
8.1.8	<i>Compatibility Work-Around Solutions</i>	302
	<i>Case Study: Incompatibility Work-Around Solution</i>	303
8.1.9	<i>Manual Execution of Test Procedures</i>	304
8.1.10	<i>Test Procedure Inspections—Peer Reviews</i>	304
8.1.11	<i>Test Procedure Configuration Management</i>	305
8.2	Test Development Guidelines	306

8.2.1	<i>Design-to-Development Transition</i>	308
8.2.2	<i>Reusable Test Procedures</i>	310
	<i>Case Study: Navigation Using Tabs or Mouse Clicks</i>	313
	<i>Case Study: Testing Bitmaps Using a Capture/Playback Tool</i>	314
8.2.3	<i>Maintainable Test Procedures</i>	317
	<i>Case Study: Automating Documentation</i>	320
	<i>Case Study: Automated Random Testing</i>	332
8.2.4	<i>Other Guidelines</i>	334
8.3	Automation Infrastructure	336
8.3.1	<i>Table-Driven Test Automation</i>	337
8.3.2	<i>PC Environment Automated Setup Script</i>	339
8.3.3	<i>Automated Recording Options</i>	340
8.3.4	<i>Login Function</i>	341
8.3.5	<i>Exit Function</i>	341
8.3.6	<i>Navigation</i>	341
8.3.7	<i>Verifying GUI Standards</i>	342
8.3.8	<i>Smoke Test</i>	342
	<i>Case Study: Smoke Test Application</i>	343
8.3.9	<i>Error-Logging Routine</i>	343
8.3.10	<i>Help Function Verification Script</i>	343
8.3.11	<i>Timed Message Boxes Function</i>	344
8.3.12	<i>Advanced Math Functions</i>	344

Part IV

Test Execution and Review

9	Test Execution	349
9.1	Executing and Evaluating Test Phases	351
9.1.1	<i>Unit Test Execution and Evaluation</i>	351
9.1.2	<i>Integration Test Execution and Evaluation</i>	354
9.1.3	<i>System Test Execution and Evaluation</i>	356
9.1.4	<i>Test Results Analysis of Regression Tests</i>	358
9.1.5	<i>User Acceptance Test Execution and Evaluation</i>	359
9.2	Defect Tracking and New Build Process	360
9.2.1	<i>Defect Life-Cycle Model</i>	366
9.3	Test Program Status Tracking	366
9.3.1	<i>Earned Value Management System</i>	367
	<i>Case Study: System Test Status Tracking</i>	367
9.3.2	<i>Test Metrics Collection and Analysis</i>	370

10	Test Program Review and Assessment	379
10.1	Test Program Lessons Learned—Corrective Actions and Improvement Activity	381
10.2	Test Program Return on Investment	392
	<i>Case Study: Test Program Return on Investment</i>	392
	<i>Case Study: Quantify Tool Return on Investment</i>	397
Part V		
Appendixes		
A	How to Test Requirements	405
A.1	Requirements Testing Approach	405
	<i>Abstract</i>	405
	<i>The Quality Gateway</i>	406
	<i>Make the Requirement Measurable</i>	406
	<i>Quantifiable Requirements</i>	406
	<i>Nonquantifiable Requirements</i>	407
	<i>Keeping Track</i>	407
	<i>Coherency and Consistency</i>	408
	<i>Completeness</i>	409
	<i>Relevance</i>	411
	<i>Requirement or Solution?</i>	412
	<i>Stakeholder Value</i>	413
	<i>Traceability</i>	413
	<i>Order in a Disorderly World</i>	414
	<i>Conclusions</i>	415
	<i>References</i>	416
B	Tools That Support the Automated Testing Life Cycle	417
B.1	Introduction	417
B.2	Business Analysis Phase	421
B.2.1	<i>Business Modeling Tools</i>	421
B.2.2	<i>Configuration Management Tools</i>	424
B.2.3	<i>Defect Tracking Tools</i>	426
B.2.4	<i>Technical Review Management</i>	432
B.2.5	<i>Documentation Generators</i>	433
B.3	Requirements Definition Phase	434
B.3.1	<i>Requirements Management Tools</i>	434
B.3.2	<i>Requirements Verifiers</i>	436
B.3.3	<i>Use Case Generators</i>	436

B.4	Analysis and Design Phase	437
B.4.1	<i>Visual Modeling Tools</i>	437
B.4.2	<i>Structure Charts, Flowcharts, and Sequence Diagrams</i>	440
B.4.3	<i>Test Procedure Generators</i>	441
B.5	Programming Phase	442
B.5.1	<i>Syntax Checkers/Debuggers</i>	442
B.5.2	<i>Memory Leak and Runtime Error Detection Tools</i>	442
B.5.3	<i>Code Checkers</i>	444
B.5.4	<i>Static and Dynamic Analyzers</i>	445
B.5.5	<i>Unit and Integration Test Tools</i>	447
B.6	Metrics Tools	450
B.6.1	<i>Code (Test) Coverage Analyzers and Code Instrumentors</i>	450
B.6.2	<i>Usability Measurement Tools</i>	456
B.7	Testing Support Tools	457
B.7.1	<i>Test Data Generators</i>	457
B.7.2	<i>File Comparison Tools</i>	458
B.7.3	<i>Simulation Tools</i>	459
B.8	Testing Phase	460
B.8.1	<i>Test Management Tools</i>	460
B.8.2	<i>Network Testing Tools</i>	460
B.8.3	<i>GUI Application Testing Tools</i>	462
B.8.4	<i>Load/Performance Testing Tools</i>	465
B.8.5	<i>Web Testing Tools</i>	470
B.8.6	<i>Year 2000 Testing Tools</i>	471
B.9	Other Test Tool Vendors	472
C	Test Engineer Development	475
C.1	Technical Skills Stage	478
C.2	Test Process Stage	480
C.3	Team Effort Stage	483
C.4	Technical Stewardship Stage	484
C.5	Test/Project Management Stage	485
C.6	Business/Product Management Stage	487
D	Sample Test Plan	489
D.1	Introduction	493
D.1.1	<i>Purpose</i>	493
D.1.2	<i>Background</i>	493

D.1.3	<i>System Overview</i>	494
D.1.4	<i>Applicable Documents</i>	496
D.1.5	<i>Master Schedule</i>	498
D.2	Roles and Responsibilities	499
D.2.1	<i>Project Organization</i>	499
D.2.2	<i>Project Roles and Responsibilities</i>	500
D.2.3	<i>Test Task Structure</i>	503
D.2.4	<i>Test Team Resources</i>	509
D.3	Test Program	509
D.3.1	<i>Scope</i>	509
D.3.2	<i>Test Approach</i>	512
D.3.3	<i>Test Strategies</i>	515
D.3.4	<i>Automated Tools</i>	518
D.3.5	<i>Qualification Methods</i>	519
D.3.6	<i>Test Requirements</i>	519
D.3.7	<i>Test Design</i>	520
D.3.8	<i>Test Development</i>	524
D.4	Test Environment	526
D.4.1	<i>Test Environment Configuration</i>	526
D.4.2	<i>Test Data</i>	527
D.5	Test Execution	529
D.5.1	<i>Test Program Reporting</i>	529
D.5.2	<i>Test Program Metrics</i>	529
D.5.3	<i>Defect Tracking</i>	530
D.5.4	<i>Configuration Management</i>	532
D.6	Detailed Test Schedule	532
	APPENDIXES	534
D.A	<i>Test Procedure Development Guidelines</i>	534
D.B	<i>Test Verification Summary and Matrix</i>	536
D.C	<i>Test Procedures and Test Scripts</i>	538
E	Best Practices	539
E.1	Documented Process	539
E.2	Managing Expectations	541
E.3	Pilot Project	541
E.4	Test Tool Compatibility Checks	541
E.5	Test Tool Upgrades	542
E.6	Baselined System Setup and Configuration	543

E.7	Software Installations in the Test Environment Baseline	543
E.8	Overall Test Program Objectives	543
E.9	Keep Automation Simple	544
E.10	Test Procedure Design and Development Standards	544
E.11	Automated Versus Manual Test Analysis	545
E.12	Reuse Analysis	545
E.13	Test Team Communication with Other Teams	545
E.14	Schedule Compatibility	546
E.15	Customer Involvement	546
E.16	Defect Documentation and Reporting	547
E.17	Automated Test Advocates and Experts	547
E.18	Test Team Assignments	547
E.19	User Group Participation	548
E.20	Test Tool Improvement Suggestions	548
E.21	Become a Beta Testing Site	548
E.22	Specialty Topic Experts	548
	<i>Index</i>	551