



Software Testing and Continuous Quality Improvement

Third Edition

William E. Lewis

Technical Contributors

David D. Dobbs • Gunasekaran Veerapillai

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

Contents

Acknowledgments	xxi
Introduction	xxiii
About the Author	xxv

SECTION 1 SOFTWARE QUALITY IN PERSPECTIVE

1 A Brief History of Software Testing	3
Historical Software Testing and Development Parallels	6
Extreme Programming	8
Evolution of Automated Testing Tools	8
Static Capture/Replay Tools (without Scripting Language)	10
Static Capture/Replay Tools (with Scripting Language)	10
Variable Capture/Replay Tools	10
2 Quality Assurance Framework	13
What Is Quality?	13
Prevention versus Detection	14
Verification versus Validation	15
Software Quality Assurance	16
Components of Quality Assurance	17
Software Testing	17
Quality Control	18
Software Configuration Management	19
Elements of Software Configuration Management	20
Software Quality Assurance Plan	23
Steps to Develop and Implement a Software Quality Assurance Plan	23
Step 1: Document the Plan	23
Step 2: Obtain Management Acceptance	25
Step 3: Obtain Development Acceptance	25

	Step 4: Plan for Implementation of the SQA Plan.....	26
	Step 5: Execute the SQA Plan.....	26
	Quality Standards.....	26
	Sarbanes–Oxley.....	26
	ISO9000.....	29
	Capability Maturity Model (CMM).....	29
	Level 1: Initial	30
	Level 2: Repeatable.....	31
	Level 3: Defined	31
	Level 4: Managed	32
	Level 5: Optimized.....	32
	People CMM.....	33
	CMMI.....	33
	Malcolm Baldrige National Quality Award.....	34
	Notes	37
3	Overview of Testing Techniques.....	39
	Black-Box Testing (Functional).....	39
	White-Box Testing (Structural)	40
	Gray-Box Testing (Functional and Structural).....	41
	Manual versus Automated Testing.....	41
	Static versus Dynamic Testing	41
	Taxonomy of Software Testing Techniques.....	42
4	Transforming Requirements to Testable Test Cases.....	51
	Introduction	51
	Software Requirements as the Basis of Testing.....	51
	Requirement Quality Factors.....	52
	Understandable.....	52
	Necessary.....	53
	Modifiable	53
	Nonredundant.....	53
	Terse	54
	Testable.....	54
	Traceable	54
	Within Scope.....	54
	Numerical Method for Evaluating Requirement Quality.....	54
	Process for Creating Test Cases from Good Requirements	55
	Step 1: Review the Requirements.....	55
	Step 2: Write a Test Plan.....	58
	Step 3: Identify the Test Suite.....	58
	Step 4: Name the Test Cases.....	59
	Step 5: Write Test Case Descriptions and Objectives.....	62

Step 6: Create the Test Cases	62
Step 7: Review the Test Cases	63
Transforming Use Cases to Test Cases.....	64
Step 1: Draw a Use Case Diagram	64
Step 2: Write the Derailed Use Case Text	64
Step 3: Identify Use Case Scenarios	66
Step 4: Generating the Test Cases.....	66
Step 5: Generating Test Data	68
Summary.....	68
What to Do When Requirements Are Nonexistent or Poor?.....	68
Ad Hoc Testing	68
The Art of Ad Hoc Testing	68
Advantages and Disadvantages of Ad Hoc Testing	71
Exploratory Testing	72
The Art of Exploratory Testing	72
Exploratory Testing Process.....	72
Advantages and Disadvantages of Exploratory Testing	73
5 Quality through Continuous Improvement Process	75
Contribution of Edward Deming.....	75
Role of Statistical Methods	76
Cause-and-Effect Diagram	76
Flowchart.....	76
Pareto Chart	76
Run Chart	77
Histogram	77
Scatter Diagram.....	77
Control Chart.....	77
Deming's 14 Quality Principles	77
Point 1: Create Constancy of Purpose.....	77
Point 2: Adopt the New Philosophy.....	78
Point 3: Cease Dependence on Mass Inspection	78
Point 4: End the Practice of Awarding Business on Price	
Tag Alone	79
Point 5: Improve Constantly and Ceaselessly the System of	
Production and Service.....	79
Point 6: Institute Training and Retraining	79
Point 7: Institute Leadership.....	80
Point 8: Drive Out Fear	80
Point 9: Break Down Barriers between Staff Areas	81
Point 10: Eliminate Slogans, Exhortations, and Targets for the	
Workforce.....	81
Point 11: Eliminate Numerical Goals	81

Point 12: Remove Barriers to Pride of Workmanship.....	82
Point 13: Institute a Vigorous Program of Education and Retraining	82
Point 14: Take Action to Accomplish the Transformation	82
<i>Continuous Improvement through the Plan, Do, Check, Act Process</i>	83
Going around the PDCA Circle	84

SECTION 2 WATERFALL TESTING REVIEW

6 Overview	87
Waterfall Development Methodology	87
Continuous Improvement “Phased” Approach	88
Psychology of Life-Cycle Testing	89
Software Testing as a Continuous Improvement Process.....	89
The Testing Bible: Software Test Plan	92
Major Steps in Developing a Test Plan.....	93
Step 1: Define the Test Objectives	93
Step 2: Develop the Test Approach	93
Step 3: Define the Test Environment	95
Step 4: Develop the Test Specifications.....	95
Step 5: Schedule the Test	95
Step 6: Review and Approve the Test Plan	95
Components of a Test Plan	95
Technical Reviews as a Continuous Improvement Process.....	96
Motivation for Technical Reviews.....	101
Types of Reviews	101
Structured Walkthroughs	101
Inspections	102
Participant Roles.....	103
Steps for an Effective Review	105
Step 1: Plan for the Review Process.....	105
Step 2: Schedule the Review	105
Step 3: Develop the Review Agenda	106
Step 4: Create a Review Report.....	106
7 Static Testing the Requirements.....	107
Testing the Requirements with Ambiguity Reviews.....	108
Testing the Requirements with Technical Reviews	109
Inspections and Walkthroughs	109
Checklists	109
Methodology Checklist	109
Requirements Traceability Matrix	110
Building the System/Acceptance Test Plan	111

8	Static Testing the Logical Design	115
	Data Model, Process Model, and the Linkage.....	115
	Testing the Logical Design with Technical Reviews	117
	Refining the System/Acceptance Test Plan.....	118
9	Static Testing the Physical Design	121
	Testing the Physical Design with Technical Reviews	121
	Creating Integration Test Cases	122
	Methodology for Integration Testing.....	123
	Step 1: Identify Unit Interfaces.....	123
	Step 2: Reconcile Interfaces for Completeness	124
	Step 3: Create Integration Test Conditions	124
	Step 4: Evaluate the Completeness of Integration Test Conditions.....	124
10	Static Testing the Program Unit Design	127
	Testing the Program Unit Design with Technical Reviews	127
	Sequence.....	127
	Selection	128
	Iteration.....	128
	Creating Unit Test Cases	128
11	Static Testing and Dynamic Testing the Code	131
	Testing Coding with Technical Reviews	131
	Executing the Test Plan	132
	Unit Testing.....	133
	Integration Testing	134
	System Testing.....	134
	Acceptance Testing.....	134
	Defect Recording.....	135

SECTION 3 SPIRAL (AGILE) SOFTWARE TESTING METHODOLOGY: PLAN, DO, CHECK, ACT

12	Development Methodology Overview	139
	Limitations of Life-Cycle Development	139
	The Client/Server Challenge	140
	Psychology of Client/Server Spiral Testing.....	141
	The New School of Thought	141
	Tester/Developer Perceptions.....	142
	Project Goal: Integrate QA and Development.....	143
	Iterative/Spiral Development Methodology	144
	Role of JADs.....	146
	Role of Prototyping.....	146

Methodology for Developing Prototypes	148
Step 1: Develop the Prototype	148
Step 2: Demonstrate Prototypes to Management	149
Step 3: Demonstrate Prototype to Users	150
Step 4: Revise and Finalize Specifications	150
Step 5: Develop the Production System	151
Continuous Improvement “Spiral” Testing Approach	151
13 Information Gathering (Plan)	155
Step 1: Prepare for the Interview	156
Task 1: Identify the Participants	156
Task 2: Define the Agenda	156
Step 2: Conduct the Interview	156
Task 1: Understand the Project	158
Task 2: Understand the Project Objectives	159
Task 3: Understand the Project Status	160
Task 4: Understand the Project Plans	160
Task 5: Understand the Project Development Methodology	161
Task 6: Identify the High-Level Business Requirements	161
Task 7: Perform Risk Analysis	162
Computer Risk Analysis	163
Method 1: Judgment and Instinct	163
Method 2: Dollar Estimation	163
Method 3: Identifying and Weighting Risk Attributes	164
Step 3: Summarize the Findings	165
Task 1: Summarize the Interview	165
Task 2: Confirm the Interview Findings	165
14 Test Planning (Plan)	167
Step 1: Build a Test Plan	168
Task 1: Prepare an Introduction	168
Task 2: Define the High-Level Functional Requirements (in Scope)	170
Task 3: Identify Manual/Automated Test Types	171
Task 4: Identify the Test Exit Criteria	171
Task 5: Establish Regression Test Strategy	172
Task 6: Define the Test Deliverables	174
Task 7: Organize the Test Team	175
Task 8: Establish a Test Environment	177
Task 9: Define the Dependencies	177
Task 10: Create a Test Schedule	178
Task 11: Select the Test Tools	178
Task 12: Establish Defect Recording/Tracking Procedures	182

Task 13: Establish Change Request Procedures	184
Task 14: Establish Version Control Procedures	185
Task 15: Define Configuration Build Procedures.....	186
Task 16: Define Project Issue Resolution Procedures	186
Task 17: Establish Reporting Procedures	187
Task 18: Define Approval Procedures	187
Step 2: Define the Metric Objectives	188
Task 1: Define the Metrics.....	188
Task 2: Define the Metric Points	189
Step 3: Review/Approve the Plan	194
Task 1: Schedule/Conduct the Review.....	194
Task 2: Obtain Approvals	194
15 Test Case Design (Do)	195
Step 1: Design Function Tests.....	195
Task 1: Refine the Functional Test Requirements	195
Task 2: Build a Function/Test Matrix.....	200
Step 2: Design GUI Tests	200
Ten Guidelines for Good GUI Design.....	200
Task 1: Identify the Application GUI Components	202
Task 2: Define the GUI Tests	202
Step 3: Define the System/Acceptance Tests	203
Task 1: Identify Potential System Tests	203
Task 2: Design System Fragment Tests	205
Task 3: Identify Potential Acceptance Tests	206
Step 4: Review/Approve Design	206
Task 1: Schedule/Prepare for Review	206
Task 2: Obtain Approvals	206
16 Test Development (Do).....	209
Step 1: Develop Test Scripts.....	209
Task 1: Script the Manual/Automated GUI/Function Tests	209
Task 2: Script the Manual/Automated System Fragment Tests	210
Step 2: Review/Approve Test Development.....	210
Task 1: Schedule/Prepare for Review	210
Task 2: Obtain Approvals	212
17 Test Coverage through Traceability	213
Use Cases and Traceability	214
Summary	216
18 Test Execution/Evaluation (Do/Check).....	217
Step 1: Setup and Testing	217
Task 1: Regression Test the Manual/Automated Spiral Fixes	217

Task 2: Execute the Manual/Automated New Spiral Tests.....	219
Task 3: Document the Spiral Test Defects.....	219
Step 2: Evaluation.....	219
Task 1: Analyze the Metrics.....	219
Step 3: Publish Interim Report	220
Task 1: Refine the Test Schedule.....	220
Task 2: Identify Requirement Changes.....	221
19 Prepare for the Next Spiral (Act).....	223
Step 1: Refine the Tests.....	223
Task 1: Update the Function/GUI Tests.....	223
Task 2: Update the System Fragment Tests.....	225
Task 3: Update the Acceptance Tests.....	225
Step 2: Reassess the Team, Procedures, and Test Environment.....	225
Task 1: Evaluate the Test Team.....	225
Task 2: Review the Test Control Procedures.....	226
Task 3: Update the Test Environment	227
Step 3: Publish Interim Test Report.....	227
Task 1: Publish the Metric Graphics.....	227
Test Case Execution Status.....	227
Defect Gap Analysis	228
Defect Severity Status.....	228
Test Burnout Tracking	228
20 Conduct the System Test (Act)	233
Step 1: Complete System Test Plan	233
Task 1: Finalize the System Test Types	233
Task 2: Finalize System Test Schedule	235
Task 3: Organize the System Test Team	235
Task 4: Establish the System Test Environment.....	238
Task 5: Install the System Test Tools	239
Step 2: Complete System Test Cases	239
Task 1: Design/Script the Performance Tests.....	239
Monitoring Approach.....	240
Probe Approach	241
Test Drivers	241
Task 2: Design/Script the Security Tests.....	242
A Security Design Strategy.....	242
Task 3: Design/Script the Volume Tests.....	243
Task 4: Design/Script the Stress Tests.....	243
Task 5: Design/Script the Compatibility Tests.....	244
Task 6: Design/Script the Conversion Tests.....	245
Task 7: Design/Script the Usability Tests.....	246

Task 8: Design/Script the Documentation Tests.....	246
Task 9: Design/Script the Backup Tests.....	247
Task 10: Design/Script the Recovery Tests	248
Task 11: Design/Script the Installation Tests	248
Task 12: Design/Script Other System Test Types.....	249
Step 3: Review/Approve System Tests	250
Task 1: Schedule/Conduct the Review.....	250
Task 2: Obtain Approvals	250
Step 4: Execute the System Tests.....	251
Task 1: Regression Test the System Fixes	251
Task 2: Execute the New System Tests.....	251
Task 3: Document the System Defects	251
21 Conduct Acceptance Testing	253
Step 1: Complete Acceptance Test Planning.....	253
Task 1: Finalize the Acceptance Test Types	253
Task 2: Finalize the Acceptance Test Schedule	255
Task 3: Organize the Acceptance Test Team	255
Task 4: Establish the Acceptance Test Environment	256
Task 5: Install Acceptance Test Tools	256
Step 2: Complete Acceptance Test Cases	256
Task 1: Identify the System-Level Test Cases	257
Task 2: Design/Script Additional Acceptance Tests	257
Step 3: Review/Approve Acceptance Test Plan	257
Task 1: Schedule/Conduct the Review.....	257
Task 2: Obtain Approvals	258
Step 4: Execute the Acceptance Tests.....	258
Task 1: Regression Test the Acceptance Fixes	258
Task 2: Execute the New Acceptance Tests.....	259
Task 3: Document the Acceptance Defects.....	259
22 Summarize/Report Test Results	261
Step 1: Perform Data Reduction	261
Task 1: Ensure All Tests Were Executed/Resolved	261
Task 2: Consolidate Test Defects by Test Number.....	261
Task 3: Post Remaining Defects to a Matrix.....	262
Step 2: Prepare Final Test Report.....	263
Task 1: Prepare the Project Overview	263
Task 2: Summarize the Test Activities	263
Task 3: Analyze/Create Metric Graphics	263
Defects by Function	264
Defects by Tester	264
Defect Gap Analysis	264

Defect Severity Status.....	264
Test Burnout Tracking	264
Root Cause Analysis	266
Defects by How Found.....	266
Defects by Who Found	267
Functions Tested and Not Tested	267
System Testing Defect Types	268
Acceptance Testing Defect Types	268
Task 4: Develop Findings/Recommendations.....	269
Step 3: Review/Approve the Final Test Report.....	272
Task 1: Schedule/Conduct the Review.....	272
Task 2: Obtain Approvals	273
Task 3: Publish the Final Test Report.....	273

SECTION 4 PROJECT MANAGEMENT METHODOLOGY

23 The Project Management Framework.....	279
The Project Framework	279
Product Quality and Project Quality	279
Components of the Project Framework.....	280
The Project Framework and Continuous Quality Improvement.....	280
The Project Framework Phases.....	281
Initiation Phase.....	281
Planning Phase	282
Executing, Monitoring, and Controlling Phases.....	282
Implement Phase	283
Scoping the Project to Ensure Product Quality.....	283
Product Scope and Project Scope.....	283
The Project Charter.....	284
The Scope Statement.....	285
The Role of the Project Manager in Quality Management.....	285
The Role of the Test Manager in Quality Management	286
Analyze the Requirements	286
Perform a Gap Analysis	286
Avoid Duplication and Repetition	287
Define the Test Data.....	287
Validate the Test Environment	287
Analyze the Test Results.....	288
Deliver the Quality.....	288
Advice for the Test Manager.....	288
Request Help from Others.....	288
Communicate Issues as They Arise.....	288
Always Update Your Business Knowledge.....	289

	Learn the New Testing Technologies and Tools.....	289
	Improve the Process.....	289
	Create a Knowledge Base.....	289
	The Benefits of the Quality Project Management and the Project Framework.....	290
24	Project Quality Management.....	291
	Project Quality Management Processes.....	291
	Quality Planning.....	292
	Identifying the High-Level Project Activities.....	292
	Estimating the Test Work Effort.....	292
	Test Planning.....	293
	Effort Estimation: Model Project.....	294
	Quality Standards.....	296
25	The Defect Management Process.....	301
	Quality Control and Defect Management.....	301
	Defect Discovery and Classification.....	301
	Defect Priority.....	302
	Defect Category.....	303
	Defect Tracking.....	303
	Defect Reporting.....	304
	Defect Summary.....	304
	Defect Meetings.....	305
	Defect Metrics.....	305
	Quality Standards.....	306
26	Integrated Testing and Development.....	309
	Quality Control and Integrated Testing.....	309
	Integrated Testing.....	309
	Step 1: Organize the Test Team.....	310
	Step 2: Identify the Tasks to Integrate.....	310
	Step 3: Customize Test Steps and Tasks.....	311
	Step 4: Select Integration Points.....	311
	Step 5: Modify the Development Methodology.....	312
	Step 6: Test Methodology Training.....	312
	Step 7: Incorporate Defect Recording.....	313
	The Integrated Team.....	313
27	Test Management Constraints.....	315
	Organizational Architecture.....	315
	Traits of a Well-Established Quality Organization.....	315
	Division of Responsibilities.....	316
	Organizational Relationships.....	317

Using the Project Framework Where No Quality Infrastructure Exists...	317
Ad Hoc Testing and the Project Framework	318
Using a Traceability/Validation Matrix.....	319
Reporting the Progress.....	319

SECTION 5 EMERGING SPECIALIZED AREAS IN TESTING

28 Test Process and Automation Assessment	323
Test Process Assessment.....	323
Process Evaluation Methodology	324
Step 1: Identify the Key Elements.....	324
Step 2: Gather and Analyze the Information	325
Step 3: Analyze Test Maturity	326
The Requirements Definition Maturity	326
Test Strategy Maturity.....	327
Test Effort Estimation Maturity	328
Test Design and Execution Maturity.....	328
Regression Testing Maturity.....	329
Test Automation Maturity.....	329
Step 4: Document and Present Findings.....	330
Test Automation Assessment.....	330
Identify the Applications to Automate	332
Identify the Best Test Automation Tool.....	332
Test Scripting Approach	333
Test Execution Approach	333
Test Script Maintenance	334
Test Automation Framework.....	334
Basic Features of an Automation Framework.....	335
Define the Folder Structure	335
Modularize Scripts/Test Data to Increase Robustness.....	336
Reuse Generic Functions and Application-Specific	
Function Libraries	336
Develop Scripting Guidelines and Review Checklists.....	336
Define Error Handling and Recovery Functions	337
Define the Maintenance Process.....	337
Standard Automation Frameworks	337
Data-Driven Framework.....	338
Modular Framework.....	338
Keyword-Driven Framework	339
Hybrid Framework	341
29 Nonfunctional Testing	343
Performance Testing	343

Load Testing.....	344
Stress Testing.....	344
Volume Testing.....	344
Performance Monitoring.....	344
Performance Testing Approach.....	344
Knowledge Acquisition Process.....	345
Test Development.....	346
Performance Deliverables.....	350
Security Testing.....	351
Step 1: Identifying the Scope of Security Testing.....	352
Step 2: Test Case Generation and Execution.....	353
Types of Security Testing.....	353
Network Scanning.....	353
Purpose.....	354
Tools.....	354
Approach.....	354
Vulnerability Scanning.....	354
Purpose.....	355
Tools.....	355
Approach.....	355
Password Cracking.....	355
Tools.....	356
Log Reviews.....	356
Approach.....	356
File Integrity Checkers.....	356
Purpose.....	356
Tools.....	357
Virus Detectors.....	357
Tools.....	357
Approach.....	357
Penetration Testing.....	357
Purpose.....	358
Approach.....	358
Usability Testing.....	358
Goals of Usability Testing.....	359
Approach and Execution.....	360
Guidelines for Usability Testing.....	361
Accessibility Testing and Section 508.....	361
Compliance Testing.....	364
30 SOA Testing.....	367
Key Steps of SOA Testing.....	368

31	Agile Testing.....	371
	Agile User Stories Contrasted to Formal Requirements	371
	What Is a User Story?	372
	Agile Planning	372
	Types of Agile Testing.....	374
	Compliance Testing.....	375
32	Testing Center of Excellence	377
	Industry Best Processes	381
	Testing Metrics	381
	Operating Model	381
	Test Automation Framework.....	382
	Continuous Competency Development	382
33	On-Site/Offshore Model.....	383
	Step 1: Analysis.....	384
	Step 2: Determine the Economic Trade-Offs.....	384
	Step 3: Determine the Selection Criteria.....	385
	Project Management and Monitoring	385
	Outsourcing Methodology.....	385
	On-Site Activities.....	386
	Offshore Activities	387
	Implementing the On-Site/Offshore Model	388
	Knowledge Transfer.....	388
	Detailed Design.....	388
	Milestone-Based Transfer	388
	Steady State	389
	Application Management.....	389
	Prerequisites	389
	Relationship Model	389
	Standards.....	391
	Benefits of On-Site/Offshore Methodology.....	392
	On-Site/Offshore Model Challenges.....	393
	Out of Sight.....	393
	Establish Transparency.....	394
	Security Considerations.....	394
	Project Monitoring	394
	Management Overhead	394
	Cultural Differences	394
	Software Licensing	394
	Future of the Onshore/Offshore Model	394

SECTION 6 MODERN SOFTWARE TESTING TOOLS

34	Software Testing Trends.....	399
	Automated Capture/Replay Testing Tools	399
	Test Case Builder Tools	400
	Necessary and Sufficient Conditions.....	400
	Test Data Generation Strategies.....	401
	Sampling from Production	401
	Starting from Scratch.....	402
	Seeding the Data	402
	Generating Data Based on the Database.....	403
	A Cutting-Edge Test Case Generator Based on Requirements.....	404
35	Taxonomy of Software Testing Tools	409
	Testing Tool Selection Checklist.....	409
	Commercial Vendor Tool Descriptions.....	410
	Open-Source Freeware Vendor Tools.....	410
	When You Should Consider Test Automation	410
	When You Should NOT Consider Test Automation	428
36	Methodology to Evaluate Automated Testing Tools.....	431
	Step 1: Define Your Test Requirements.....	431
	Step 2: Set Tool Objectives	432
	Step 3a: Conduct Selection Activities for Informal Procurement	432
	Task 1: Develop the Acquisition Plan	432
	Task 2: Define Selection Criteria	432
	Task 3: Identify Candidate Tools.....	433
	Task 4: Conduct the Candidate Review.....	433
	Task 5: Score the Candidates.....	433
	Task 6: Select the Tool.....	434
	Step 3b: Conduct Selection Activities for Formal Procurement.....	434
	Task 1: Develop the Acquisition Plan	434
	Task 2: Create the Technical Requirements Document	434
	Task 3: Review Requirements.....	434
	Task 4: Generate the Request for Proposal.....	434
	Task 5: Solicit Proposals	435
	Task 6: Perform the Technical Evaluation	435
	Task 7: Select a Tool Source.....	435
	Step 4: Procure the Testing Tool.....	436
	Step 5: Create the Evaluation Plan	436
	Step 6: Create the Tool Manager's Plan	436
	Step 7: Create the Training Plan	437
	Step 8: Receive the Tool.....	437

Step 9: Perform the Acceptance Test.....	437
Step 10: Conduct Orientation.....	437
Step 11: Implement Modifications	438
Step 12: Train Tool Users	438
Step 13: Use the Tool in the Operating Environment	438
Step 14: Write the Evaluation Report.....	439
Step 15: Determine Whether Goals Have Been Met.....	439

SECTION 7 APPENDICES

Appendix A: Spiral (Agile) Testing Methodology	443
Appendix B: Software Quality Assurance Plan	453
Appendix C: Requirements Specification.....	455
Appendix D: Change Request Form.....	457
Appendix E: Test Templates	459
Appendix F: Checklists	493
Appendix G: Software Testing Techniques	557
Bibliography.....	629
Glossary.....	633
Index	641