

Richard Blum and Christine Bresnahan

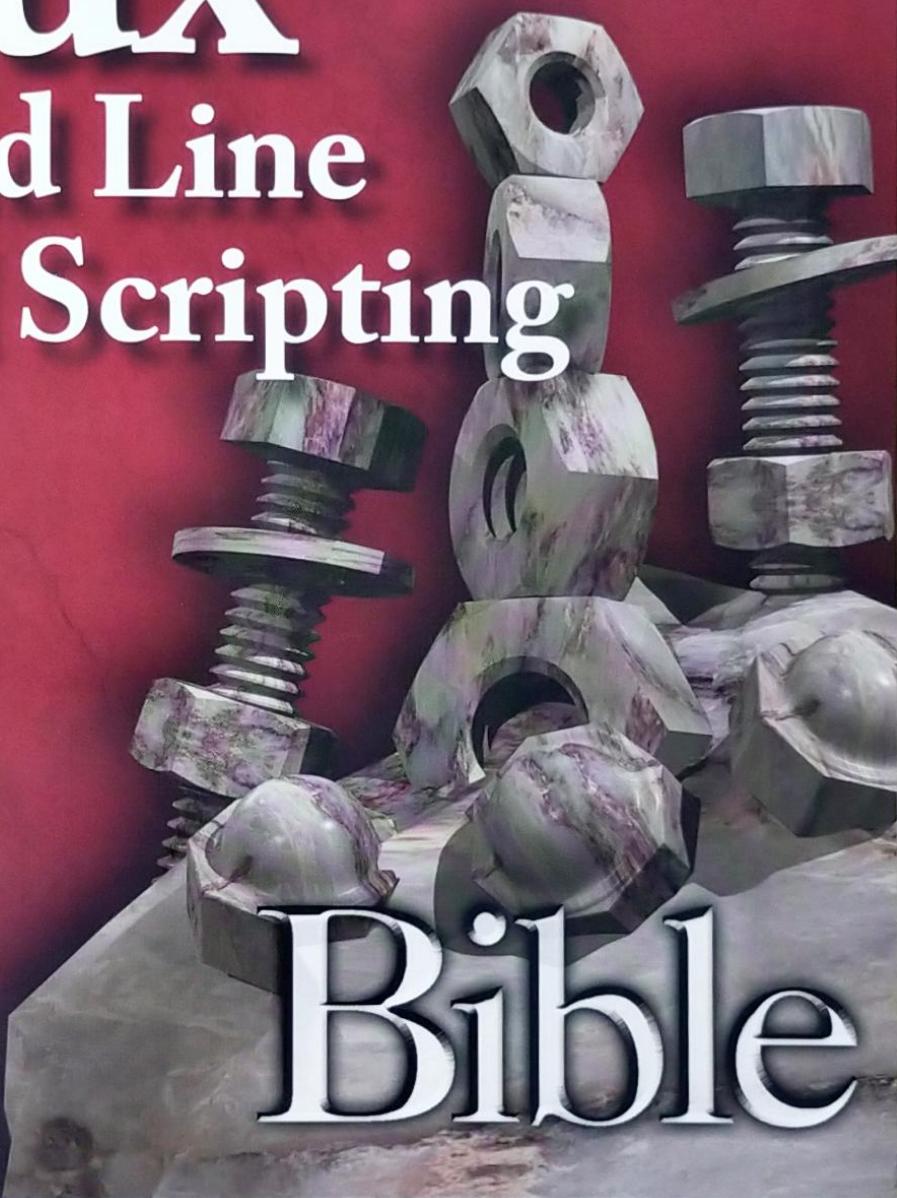
Linux® Command Line and Shell Scripting

Second Edition

Use command lines and
bypass the GUI

Automate common tasks

Create professional,
real-world scripts

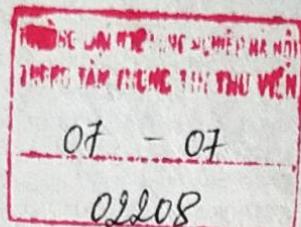


Bible

The book you need to succeed!

Linux® Command Line and Shell Scripting Bible

Second Edition



**Richard Blum
Christine Bresnahan**



WILEY

Wiley Publishing, Inc.

Linux® Command Line and Shell Scripting Bible, Second Edition

Published by

Wiley Publishing, Inc.

10475 Crosspoint Boulevard

Indianapolis, IN 46256

www.wiley.com

Copyright © 2011 by Wiley Publishing, Inc., Indianapolis, Indiana

Published simultaneously in Canada

ISBN: 978-1-118-00442-5

ISBN: 978-1-118-08777-0 (ebk)

ISBN: 978-1-118-08778-7 (ebk)

ISBN: 978-1-118-08779-4 (ebk)

Manufactured in the United States of America

10 9 8 7 6 5 4 3

No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning or otherwise, except as permitted under Sections 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 646-8600. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008, or online at <http://www.Wiley.com/go/permissions>.

Limit of Liability/Disclaimer of Warranty: The publisher and the author make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation warranties of fitness for a particular purpose. No warranty may be created or extended by sales or promotional materials. The advice and strategies contained herein may not be suitable for every situation. This work is sold with the understanding that the publisher is not engaged in rendering legal, accounting, or other professional services. If professional assistance is required, the services of a competent professional person should be sought. Neither the publisher nor the author shall be liable for damages arising herefrom. The fact that an organization or Web site is referred to in this work as a citation and/or a potential source of further information does not mean that the author or the publisher endorses the information the organization or website may provide or recommendations it may make. Further, readers should be aware that Internet websites listed in this work may have changed or disappeared between when this work was written and when it is read.

For general information on our other products and services please contact our Customer Care Department within the United States at (877) 762-2974, outside the United States at (317) 572-3993 or fax (317) 572-4002.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

Library of Congress Control Number: 2011921770

Trademarks: Wiley and the Wiley logo are trademarks or registered trademarks of John Wiley & Sons, Inc. and/or its affiliates, in the United States and other countries, and may not be used without written permission. Linux is a registered trademark of Linus Torvalds. All other trademarks are the property of their respective owners. Wiley Publishing, Inc. is not associated with any product or vendor mentioned in this book.

Credits

Acquisitions Editor
Mary James

Project Editor
Brian Herrmann

Technical Editor
Jack Cox

Production Editor
Daniel Scribner

Copy Editor
Nancy Rapoport

Editorial Director
Robyn B. Siesky

Editorial Manager
Mary Beth Wakefield

Freelancer Editorial Manager
Rosemarie Graham

Marketing Manager
Ashley Zurcher

Production Manager
Tim Tate

Vice President and Executive Group Publisher
Richard Swadley

Vice President and Executive Publisher
Barry Pruett

Associate Publisher
Jim Minatel

Project Coordinator, Cover
Katherine Crocker

Proofreader
Publication Services, Inc.

Indexer
Robert Swanson

Cover Designer
Ryan Sneed

Cover Image
Joyce Haughey

About the Authors

Richard Blum has worked in the IT industry for more than 20 years as both a systems and network administrator, and has published numerous Linux and open source books. He has administered UNIX, Linux, Novell, and Microsoft servers, as well as helped design and maintain a 3,500 user network utilizing Cisco switches and routers. He has used Linux servers and shell scripts to perform automated network monitoring, and has written shell scripts in most of the common Linux shell environments. Rich is an online instructor for an Introduction to Linux course that is used by colleges and universities across the U.S. When he's not being a computer nerd, Rich plays electric bass in a couple of different church worship bands, and enjoys spending time with his wife Barbara, and two daughters Katie Jane and Jessica.

Christine Bresnahan starting working with computers more than 25 years ago in the IT industry as a system administrator. Christine is currently an Adjunct Professor at Ivy Tech Community College in Indianapolis, Indiana, teaching Linux system administration, Linux security, and Windows security classes.

About the Technical Editor

Jack Cox is a Senior Manager with CapTech Ventures in Richmond, VA. He has more than 25 years of experience in IT, spanning a broad range of disciplines including mobile computing, transaction processing, RFID, Java development, and cryptography. Jack enjoys life in Richmond with his lovely wife and rambunctious children. Outside of technology, his interests include church, his children, and extended family.

Acknowledgments

First, all glory and praise go to God, who through His Son, Jesus Christ, makes all things possible, and gives us the gift of eternal life.

Many thanks go to the fantastic team of people at John Wiley & Sons for their outstanding work on this project. Thanks to Mary James, the acquisitions editor, for offering us the opportunity to work on this book. Also thanks to Brian Herrmann, the project editor, for keeping things on track and making this book more presentable. Thanks, Brian, for all your hard work and diligence. The technical editor, Jack Cox, did a wonderful job of double checking all the work in the book, plus making suggestions to improve the content. Thanks to Nancy Rapoport, the copy editor, for her endless patience and diligence to make our work readable. We would also like to thank Carole McClendon at Waterside Productions, Inc., for arranging this opportunity for us, and for helping us out in our writing careers.

Christine would like to thank her husband, Timothy, for his encouragement, patience, and willingness to listen, even when he has no idea what she is talking about.

Contents at a Glance

Introduction	xxv
--------------------	-----

Part I: The Linux Command Line 1

Chapter 1: Starting with Linux Shells	3
Chapter 2: Getting to the Shell	25
Chapter 3: Basic bash Shell Commands	61
Chapter 4: More bash Shell Commands	95
Chapter 5: Using Linux Environment Variables	129
Chapter 6: Understanding Linux File Permissions	155
Chapter 7: Managing Filesystems	179
Chapter 8: Installing Software	201
Chapter 9: Working with Editors	223

Part II: Shell Scripting Basics 251

Chapter 10: Basic Script Building	253
Chapter 11: Using Structured Commands	281
Chapter 12: More Structured Commands	309
Chapter 13: Handling User Input	337
Chapter 14: Presenting Data	365
Chapter 15: Script Control	387

PART III: Advanced Shell Scripting 415

Chapter 16: Creating Functions	417
Chapter 17: Writing Scripts for Graphical Desktops	439
Chapter 18: Introducing sed and gawk	467
Chapter 19: Regular Expressions	495
Chapter 20: Advanced sed	521
Chapter 21: Advanced gawk	549
Chapter 22: Working with Alternative Shells	579

Part IV: Advanced Shell Scripting Topics 609

Chapter 23: Using a Database	611
Chapter 24: Using the Web	643

Contents at a Glance

Chapter 25: Using E-mail.....	665
Chapter 26: Writing Script Utilities	689
Chapter 27: Advanced Shell Scripts.....	717
Appendix A: Quick Guide to bash Commands	751
Appendix B: Quick Guide to sed and gawk.....	761
Index.....	773

Contents

Introduction	xxv
<hr/>	
Part I: The Linux Command Line	1
<hr/>	
Chapter 1: Starting with Linux Shells	3
What Is Linux?	3
Looking into the Linux Kernel	4
The GNU Utilities.....	12
The Linux Desktop Environment	14
Linux Distributions	20
Core Linux Distributions.....	21
Specialized Linux Distributions.....	22
The Linux LiveCD	23
Summary.....	24
Chapter 2: Getting to the Shell.	25
Terminal Emulation.....	25
Graphics Capabilities.....	27
The Keyboard	30
The terminfo Database	31
The Linux Console	35
The xterm Terminal.....	37
Command Line Parameters	37
The xterm Main Menu	39
The VT Options Menu.....	42
The VT Fonts Menu	44
The Konsole Terminal	46
Command Line Parameters	46
Tabbed Window Sessions	47
Profiles.....	49
The Menu Bar	49
The GNOME Terminal	54
The Command Line Parameters.....	54
Tabs	55
The Menu Bar	57
Summary.....	60

Contents

Chapter 3: Basic bash Shell Commands	61
Starting the Shell	61
The Shell Prompt.....	62
The Bash Manual	65
Filesystem Navigation	66
The Linux Filesystem.....	67
Traversing Directories.....	69
File and Directory Listing.....	71
Basic Listing.....	71
Modifying the Information Presented.....	73
The Complete Parameter List.....	74
Filtering Listing Output.....	77
File Handling	78
Creating Files.....	78
Copying Files.....	79
Linking Files.....	81
Renaming Files.....	83
Deleting Files.....	83
Directory Handling	85
Creating Directories.....	85
Deleting Directories.....	85
Viewing File Contents	86
Viewing File Statistics.....	86
Viewing the File Type	87
Viewing the Whole File	87
Viewing Parts of a File	92
Summary.....	93
Chapter 4: More bash Shell Commands	95
Monitoring Programs	95
Peeking at the Processes	95
Real-Time Process Monitoring	104
Stopping Processes	107
Monitoring Disk Space	109
Mounting Media	109
Using the df Command	113
Using the du Command	114
Working with Data Files.....	115
Sorting Data.....	115
Searching for Data	120
Compressing Data	121
Archiving Data.....	125
Summary.....	127

Chapter 5: Using Linux Environment Variables	129
What Are Environment Variables?.....	129
Global Environment Variables.....	130
Local Environment Variables.....	131
Setting Environment Variables	134
Setting Local Environment Variables.....	134
Setting Global Environment Variables.....	136
Removing Environment Variables	136
Default Shell Environment Variables	137
Setting the PATH Environment Variable.....	142
Locating System Environment Variables	143
Login Shell.....	144
Interactive Shell	147
Non-Interactive Shell.....	150
Variable Arrays.....	150
Using Command Aliases	152
Summary.....	153
Chapter 6: Understanding Linux File Permissions	155
Linux Security	155
The /etc/passwd File	156
The /etc/shadow File	158
Adding a New User	158
Removing a User	161
Modifying a User	162
Using Linux Groups	165
The /etc/group File	166
Creating New Groups	167
Modifying Groups	168
Decoding File Permissions	168
Using File Permission Symbols	168
Default File Permissions	170
Changing Security Settings	172
Changing Permissions	172
Changing Ownership	173
Sharing Files	175
Summary.....	176
Chapter 7: Managing Filesystems	179
Exploring Linux Filesystems	179
The Basic Linux Filesystems	179
Journaling Filesystems	181
The Extended Linux Journaling Filesystems	182

Contents

Working with Filesystems	184
Creating Partitions.....	184
Creating a Filesystem.....	187
If Things Go Wrong.....	189
Logical Volume Managers.....	190
The Logical Volume Management Layout	191
The LVM in Linux.....	192
Using the Linux LVM.....	193
Summary.....	199
Chapter 8: Installing Software	201
Package Management Primer.....	201
The Debian-Based Systems	202
Managing Packages with aptitude.....	203
Installing Software Packages with aptitude	205
Updating Software with aptitude	207
Uninstalling Software with aptitude	208
The aptitude Repositories	209
The Red Hat-Based Systems.....	210
Listing Installed Packages.....	211
Installing Software with yum	213
Updating Software with yum.....	214
Uninstalling Software with yum.....	215
Dealing with Broken Dependencies.....	215
Yum Repositories.....	217
Installing from Source Code.....	218
Summary.....	221
Chapter 9: Working with Editors	223
The vim Editor	223
The Basics of vim.....	224
Editing Data.....	226
Copy and Paste	227
Search and Substitute	227
The emacs Editor.....	228
Using emacs on the Console	229
Using emacs in X Windows	234
The KDE Family of Editors.....	235
The KWrite Editor	236
The Kate Editor.....	240
The GNOME Editor.....	244
Starting gedit	244
Basic gedit Features	245
Setting Preferences.....	245
Summary.....	249

Part II: Shell Scripting Basics	251
Chapter 10: Basic Script Building	253
Using Multiple Commands.....	253
Creating a Script File.....	254
Displaying Messages.....	256
Using Variables.....	257
Environment Variables.....	258
User Variables.....	259
The Backtick.....	261
Redirecting Input and Output.....	262
Output Redirection.....	262
Input Redirection.....	263
Pipes.....	264
Performing Math	268
The expr Command.....	268
Using Brackets	270
A Floating-Point Solution.....	271
Exiting the Script	275
Checking the exit Status.....	275
The exit Command.....	277
Summary.....	278
Chapter 11: Using Structured Commands	281
Working with the if-then Statement.....	281
The if-then-else Statement.....	284
Nesting ifs	284
The test Command.....	285
Numeric Comparisons.....	286
String Comparisons.....	288
File Comparisons.....	293
Compound Condition Testing.....	301
Advanced if-then Features.....	302
Using Double Parentheses.....	302
Using Double Brackets.....	304
The case Command.....	305
Summary.....	306
Chapter 12: More Structured Commands	309
The for Command	309
Reading Values in a List.....	310
Reading Complex Values in a List.....	311
Reading a List from a Variable	313
Reading Values from a Command.....	314

Contents

Changing the Field Separator	315
Reading a Directory Using Wildcards.....	316
The C-Style for Command	318
The C Language for Command.....	318
Using Multiple Variables.....	320
The while Command	320
Basic while Format	321
Using Multiple Test Commands.....	322
The until Command.....	323
Nesting Loops	325
Looping on File Data.....	327
Controlling the Loop	328
The break Command	329
The continue Command	332
Processing the Output of a Loop	334
Summary.....	336
Chapter 13: Handling User Input	337
Command Line Parameters	337
Reading Parameters	337
Reading the Program Name	340
Testing Parameters.....	341
Special Parameter Variables	342
Counting Parameters	342
Grabbing All the Data	344
Being Shifty	346
Working with Options	347
Finding Your Options	347
Using the getopt Command	351
The More Advanced getopts	354
Standardizing Options	357
Getting User Input.....	358
Basic Reading	358
Timing Out	360
Silent Reading	361
Reading from a File	362
Summary.....	362
Chapter 14: Presenting Data	365
Understanding Input and Output	365
Standard File Descriptors	365
Redirecting Errors	368
Redirecting Output in Scripts	370

Temporary Redirections	370
Permanent Redirections	371
Redirecting Input in Scripts	372
Creating Your Own Redirection	373
Creating Output File Descriptors.....	373
Redirecting File Descriptors	374
Creating Input File Descriptors	375
Creating a Read/Write File Descriptor.....	375
Closing File Descriptors.....	376
Listing Open File Descriptors.....	378
Suppressing Command Output.....	380
Using Temporary Files.....	380
Creating a Local Temporary File.....	381
Creating a Temporary File in /tmp.....	382
Creating a Temporary Directory	383
Logging Messages.....	384
Summary.....	385
Chapter 15: Script Control	387
Handling Signals	387
Linux Signals Revisited.....	387
Generating Signals.....	388
Trapping Signals	390
Trapping a Script Exit.....	391
Removing a Trap.....	392
Running Scripts in Background Mode.....	393
Running in the Background.....	393
Running Multiple Background Jobs.....	394
Exiting the Terminal.....	395
Running Scripts Without a Console	395
Job Control.....	396
Viewing Jobs.....	397
Restarting Stopped Jobs.....	399
Being Nice	400
The nice Command	400
The renice Command	401
Running Like Clockwork	402
Scheduling a Job Using the at Command	402
Scheduling Regular Scripts.....	405
Start at the Beginning.....	409
Starting Your Scripts at Boot Time.....	409
Starting with a New Shell	412
Summary.....	412

Contents

PART III: Advanced Shell Scripting	415
Chapter 16: Creating Functions	417
Basic Script Functions	417
Creating a Function	418
Using Functions	418
Returning a Value	420
The Default Exit Status	421
Using the return Command	422
Using Function Output	423
Using Variables in Functions	424
Passing Parameters to a Function	424
Handling Variables in a Function	426
Array Variables and Functions	429
Passing Arrays to Functions	429
Returning Arrays from Functions	431
Function Recursion	432
Creating a Library	433
Using Functions on the Command Line	435
Creating Functions on the Command Line	435
Defining Functions in the .bashrc File	436
Summary	438
Chapter 17: Writing Scripts for Graphical Desktops	439
Creating Text Menus	439
Create the Menu Layout	439
Create the Menu Functions	441
Add the Menu Logic	442
Putting It All Together	442
Using the select Command	444
Doing Windows	445
The dialog Package	446
The dialog Options	453
Using the dialog Command in a Script	455
Getting Graphic	457
The KDE Environment	457
The GNOME Environment	461
Summary	466
Chapter 18: Introducing sed and gawk	467
Text Manipulation	467
The sed Editor	468
The gawk Program	471
The sed Editor Basics	477
More Substitution Options	478

Using Addresses	480
Deleting Lines.....	482
Inserting and Appending Text.....	484
Changing Lines.....	486
The transform Command	487
Printing Revisited	488
Using Files with sed.....	490
Summary.....	493
Chapter 19: Regular Expressions	495
What Are Regular Expressions?.....	495
A Definition	495
Types of Regular Expressions	496
Defining BRE Patterns.....	497
Plain Text.....	497
Special Characters	499
Anchor Characters.....	500
The Dot Character	502
Character Classes	503
Negating Character Classes	505
Using Ranges	505
Special Character Classes	507
The Asterisk.....	508
Extended Regular Expressions	509
The Question Mark.....	510
The Plus Sign	510
Using Braces	511
The Pipe Symbol.....	512
Grouping Expressions	513
Regular Expressions in Action.....	514
Counting Directory Files	514
Validating a Phone Number	515
Parsing an E-mail Address	517
Summary.....	519
Chapter 20: Advanced sed	521
Multiline Commands	521
The next Command	522
The Multiline delete Command	525
The Multiline print Command	526
The Hold Space.....	527
Negating a Command.....	529
Changing the Flow	531
Branching	532
Testing	533
Pattern Replacement.....	535

Contents

The Ampersand	535
Replacing Individual Words	535
Using sed in Scripts	537
Using Wrappers	537
Redirecting sed Output	538
Creating sed Utilities	538
Double Spacing Lines	539
Double Spacing Files That May Have Blanks	539
Numbering Lines in a File	540
Printing Last Lines	541
Deleting Lines	542
Removing HTML Tags	545
Summary	547
Chapter 21: Advanced gawk	549
Using Variables	549
Built-in Variables	549
User-Defined Variables	556
Working with Arrays	558
Defining Array Variables	558
Iterating Through Array Variables	559
Deleting Array Variables	560
Using Patterns	560
Regular Expressions	560
The Matching Operator	561
Mathematical Expressions	562
Structured Commands	563
The if Statement	563
The while Statement	565
The do-while Statement	566
The for Statement	567
Formatted Printing	567
Built-in Functions	570
Mathematical Functions	571
String Functions	572
Time Functions	574
User-Defined Functions	575
Defining a Function	575
Using Your Functions	576
Creating a Function Library	576
Summary	577
Chapter 22: Working with Alternative Shells	579
What Is the dash Shell?	579
The dash Shell Features	580

The dash Command Line Parameters	581
The dash Environment Variables	582
The dash Built-in Commands	585
Scripting in dash	586
Creating dash Scripts	586
Things That Won't Work	586
The zsh Shell	592
Parts of the zsh Shell	592
Shell Options	592
Built-in Commands	596
Scripting with zsh	602
Mathematical Operations	602
Structured Commands	604
Functions	604
Summary	607

Part IV: Advanced Shell Scripting Topics **609**

Chapter 23: Using a Database

611

The MySQL Database	611
Installing MySQL	612
The MySQL Client Interface	614
Creating MySQL Database Objects	619
The PostgreSQL Database	622
Installing PostgreSQL	622
The PostgreSQL Command Interface	623
Creating PostgreSQL Database Objects	626
Working with Tables	627
Creating a Table	628
Inserting and Deleting Data	630
Querying Data	631
Using the Database in Your Scripts	633
Connecting to the Databases	633
Sending Commands to the Server	635
Formatting Data	639
Summary	640

Chapter 24: Using the Web

643

The Lynx Program	643
Installing Lynx	644
The lynx Command Line	645
The Lynx Configuration File	652
The Lynx Environment Variables	653
Capturing Data from Lynx	654

Contents

The cURL Program	657
Installing cURL	657
Exploring with cURL	657
Networking with zsh	658
The TCP Module	658
The Client/Server Paradigm	659
Client/Server Programming with zsh	660
Summary	664
Chapter 25: Using E-mail	665
The Basics of Linux E-Mail	665
E-Mail in Linux	665
The Mail Transfer Agent	667
The Mail Delivery Agent	668
The Mail User Agent	669
Setting Up Your Server	673
sendmail	674
Postfix	676
Sending a Message with Mailx	681
The Mutt Program	684
Installing Mutt	684
The Mutt Command Line	685
Using Mutt	686
Summary	687
Chapter 26: Writing Script Utilities	689
Monitoring Disk Space	689
The Required Functions	689
Creating the Script	692
Running the Script	693
Performing Backups	694
Archiving Data Files	695
Managing User Accounts	702
The Required Functions	702
Creating the Script	709
Summary	716
Chapter 27: Advanced Shell Scripts	717
Monitoring System Statistics	717
System Snapshot Report	717
System Statistics Report	725
Problem-Tracking Database	733
Creating the Database	733
Recording a Problem	736
Updating a Problem	739
Finding a Problem	745
Summary	749

Appendix A: Quick Guide to bash Commands	751
Built-in Commands.....	751
Bash Commands.....	754
Environment Variables.....	756
Appendix B: Quick Guide to sed and gawk	761
The sed Editor	761
Starting the sed Editor.....	761
sed Commands.....	762
The gawk Program	766
The gawk Command Format.....	766
Using gawk.....	767
The gawk Variables.....	768
The gawk Program Features	771
Index	773