THE STUDENT EDITION OF

MINITAB® 8

Statistical software...adapted for education

User's Manual by Robert L. Schaefer & Elizabeth Farber Addison-Wesley



THE STUDENT EDITION OF MINITAB® 8

Statistical software...adapted for education

Robert L. Schaefer Miami University at Oxford

Elizabeth Farber Bucks County Community College





Addison-Wesley Publishing Company, Inc. Benjamin/Cummings Publishing Company, Inc.

Reading, Massachusetts · Redwood City, California · New York Don Mills, Ontario · Wokingham, England · Amsterdam · Bonn Sydney · Singapore · Tokyo · Madrid · San Juan · Milan · Paris

To my wife Alayne and my dad -R.L.S.

To my husband Richard and my sons Douglas and Michael —E.F.

The Student Edition of MINITAB is published by Addison-Wesley Publishing Company, Inc. and Benjamin/Cummings Publishing Company, Inc. Contributors included:

Betsy Burr, Sponsoring Editor
Kristen Duerr, Project Coordinator
Barbara Clemens, Project Manager
Joan Carey, Developmental Editor
Mary Coffey, Production Manager
Nancy Benjamin, Production Supervisor
Susan Marsh, Text Designer
Linda Enrico, Cover and Package Designer
Joeth Barlas, Copy Editor
Patricia Gordon, Manufacturing Media Supervisor
TSI Graphics, Inc., Compositor

Photo and Minitab at Work credits appear on p. 592, which constitutes an extension of the copyright page.

Trademarks: MINITAB/Minitab is a registered trademark of Minitab Inc. miniWRITER is a trademark of Maitreya Design. Microsoft is a registered trademark of Microsoft Corporation. Excel and Word are products of Microsoft Corporation. Macintosh, Apple, Appleshare, Imagewriter, and Laser Writer are registered trademarks of Apple Computer, Inc.

General Notice: Some of the product names used herein have been used for identification purposes only and may be trademarks of their respective companies.

The Student Edition of MINITAB User's Manual Copyright © 1992, Addison-Wesley Publishing Company, Inc.

The Student Edition of MINITAB software Copyright © 1991, Minitab Inc. All rights reserved. Certain portions of this software are copyrighted by Language Systems Corp. © 1988, 1989.

It is a violation of copyright law to make a copy of the accompanying software except for backup purposes to guard against accidental loss or damage. Addison-Wesley assumes no responsibility for errors arising from duplication of the original programs.

All rights reserved. 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, or otherwise, without the prior written permission of the publisher. Printed in the United States.

Reprinted July, 1994. ISBN 0-201-50648-3 (Macintosh format) ISBN 0-201-82052-8 (User's Manual)

Note: This product is also available in DOS format.

PREFACE

Welcome to The Student Edition of Minitab.

Minitab is a powerful tool originally developed at The Pennsylvania State University as a teaching aid for introductory statistics courses. Minitab is one of the most widely accepted statistical analysis packages for college instruction, and is currently used at over 2,000 schools. Minitab has also proven itself as an established research tool and is installed on mainframe, mini, and microcomputers at over 3,000 sites in 51 countries worldwide, and is used by three-quarters of the companies listed in *Fortune* magazine's listing of the top 50 companies. Except for a few features, The Student Edition of Minitab is an identical version of this program and is designed to provide students with a tool for describing, analyzing, and displaying data.

The Student Edition of Minitab includes the following:

- a menu-driven interface providing easy access to all Minitab's statistical, graphical, and data management capabilities
- a data window permitting data entry, editing, and browsing in a spreadsheet-like display
- an on-screen help window that displays information on Minitab menus, commands, and options
- the ability to import and export data from tab-delimited files
- statistical process control charts

 similar interface, commands, and output across Macintosh and DOS platforms

Objectives

The Student Edition of Minitab is designed to introduce students to a powerful statistical analysis program they can use to analyze and describe data. The primary objectives of the package are:

- to provide a complete educational environment for learning Minitab
- to provide students with a powerful and versatile tool that will enhance their learning experience
- to teach students the basics of Minitab in the context of case studies and data from business, life sciences, engineering, and the social sciences
- to provide teachers with a flexible means of integrating technology into their classrooms

What's in This Edition?

The Student Edition of Minitab for the Macintosh features the same functionality as the previous IBM PC Student Edition, with the following new or enhanced features.

Software

- larger worksheets that allow up to 3500 data points and up to 100 columns
- menu-driven graphical user interface with pull-down menus, dialog boxes, and improved access to help information
- the Minitab command language is still available
- data editor that allows data entry and editing in a spreadsheet format
- high-resolution graphics for histograms, boxplots, scatter plots, multiple scatter plots, and control charts
- titles, footnotes, axis labels on both low- and high-resolution scatter and multiple scatter plots
- multiple comparison procedures including Tukey, Fisher, Dunnet, and MCB with one-way analysis of variance

PREFACE vii

- SORT of multiple columns with BY and DESCENDING
- alpha data up to 80 characters long supported in COPY, DELETE, INFO, READ, INSERT, SORT, STACK, UNSTACK, and WRITE
- various additional commands, i.e., INDICATOR, YESNO, SAMPLE, MTSPLOT, COVARIANCE, CENTER, ONEWAY, ANOVA
- eleven statistical process control charts, including XBARCHART, RCHART, PCHART, and ICHART

Manual

- new tutorials, including a tutorial on statistical process control charts, and an expanded tutorial on macros
- completely new examples, case studies, and exercises
- new data sets throughout with an emphasis on real-world data
- "Minitab at Work" boxes that show how Minitab is used in organizations throughout the United States
- Exploring Data section that describes all data sets, including five larger data sets with suggestions for analysis

Organization of This Manual

The manual is organized into four sections. Part I, Getting Started, begins by detailing the contents of the Student Edition package. Chapter 1 includes a concise explanation of the conventions used throughout the manual, an introduction to the fundamentals of the Macintosh, and information regarding technical support. Chapters 2 and 3 include complete, easy-to-follow instructions for installing, starting, and exiting Minitab. Chapter 4 consists of a comprehensive sample session, designed to give students an overview of the program and to interest them in its capabilities.

Part II, Tutorials, is the heart of the manual. It contains fourteen interactive tutorials that teach students how to use Minitab by working with case studies from business, engineering, life sciences, and the social sciences.

Each tutorial begins with a list of objectives, and includes case studies that introduce students to Minitab commands. As students perform steps in the tutorial, screen views are shown in the manual to keep students on track and illustrate Minitab concepts and features. Each tutorial requires approximately 45 minutes to complete (not including practice problems).

Each tutorial ends with a summary and review section that includes a list of menu items that were introduced in or related to that tutorial. A set of practice problems follows, using the data sets from the tutorials as well as introducing new data sets. In selected tutorials, a "Minitab at Work" section illustrates how Minitab is used in organizations throughout the United States.

For those students unfamiliar with Minitab, the first four tutorials, dealing with data entry, manipulation, description, and summary, should be completed in order. The remaining tutorials can be completed in any sequence; however, the student should note that some tutorials are based on case studies introduced in earlier tutorials. The experienced Minitab user could proceed with any tutorial.

Part III, Exploring Data, contains descriptions of all the data sets used in the tutorials and practice problems. It also includes additional data sets, as well as larger data sets with suggestions for analysis.

Part IV, Reference, describes all of Minitab's features. It contains comprehensive descriptions of the Minitab commands, menus, functions, and Minitab basics. It also contains a discussion of selected Minitab topics, such as file types, importing and exporting data, and time-saving hints. In addition, it features chapters on more advanced topics, the Minitab command language and macros. Menu commands are cross-referenced to their corresponding Session window commands and the tutorials.

The Differences Between the Student Edition and the Commercial Version

The Student Edition is completely compatible with the commercial program but has the following limitations:

- the worksheet is limited to 3,500 data points and 100 columns
- matrix functions are not included
- selected commands have not been included (see Appendix E for a complete listing)

PREFACE

Acknowledgments

The completion of this revision of The Student Edition of Minitab took over seven months and demanded a diverse team. At this time, we could not possibly list the complete team, since we had limited, if any, interaction with most of its members. Long before we wrote our first sentence, there were those who outlined what this manual would look like. Long after we wrote our last word, others took over to edit, produce, distribute, and market the final product. Everyone on the team, and their contributions, was crucial to the success of the revision. In particular, we would like to recognize those individuals with whom we worked on a regular basis.

Betsy Burr was instrumental in getting this project started. From her preliminary contact meeting to recruiting the final team, her organizational skill is attested to by the fact that this manuscript was completed well within schedule and incorporates her vision of what The Student Edition of Minitab would be. Many of the innovative features of this edition are due to her.

On a day-to-day basis we operated most closely and most frequently with Barbara Clemens and Kristen Duerr. The ambitious schedule, which seemed impossible at times, was easily met through their efforts. To successfully coordinate activities spanning three seasons of the year, four states, two time zones, and three word processing systems on two different computer platforms demanded extraordinary patience, a never-ending sense of humor, and exceptional managerial skills. We could not have done it without both of them.

Joan Carey's developmental editing improved the manuscript with each reading. Her merger of the new user interface and the Minitab command language in the reference section was a stroke of genius. To do all of this so professionally and competently and on schedule, while caring for twin one-year-olds, still amazes us.

Our thanks to the staff and programmers of Minitab, Inc., especially to Mike McCormick, Gwen Stimely, and Steve Fine, who provided us with their technical expertise and created the software for this package.

Alan Jacobs provided valuable, and much appreciated, insight and solutions to particularly annoying problems.

Finally, we are grateful to the many reviewers who took time to find many of the typos, misspellings, and non sequiturs that somehow find their way into every manuscript. Your questions, comments, and suggestions have significantly improved this manual.

We would also like to thank the many reviewers and class testers whose diligent reading and thoughtful comments strengthened this work immeasurably.

Reviewers

William Hannum, Syracuse University, New York Richard S. Lehman, Franklin and Marshall, Pennsylvania Don Myers, University of Arizona, Arizona Alex Olsen, University of Lowell, Massachusetts Calvin Williams, Clemson University, South Carolina

Class Testers

University of Lowell, Massachusetts
Alex Olsen, Coordinator
Joyce Elder, Student Tester
David Hedison, Student Tester
Joseph Misserville, Student Tester
Lyn Ann Misserville, Student Tester
Danielle White, Student Tester

Clemson University, South Carolina
Calvin Williams, Coordinator
Juliette Atkins, Student Tester
Wendy Cullen, Student Tester
Christopher Custodio, Student Tester
Amy Dickerson, Student Tester
Raymond Griffith, Student Tester

Robert L. Schaefer Elizabeth Farber

CONTENTS

Part I Getting Started

Chapter 1: Before You Begin 5

Checking Your Package 5 What's in This Book? 5 Required Computer System 6 Typographical Conventions 7 Technical Support 8 Macintosh Basics 8 Welcome 8 The Desktop 8 Using the Mouse 10 Mouse Techniques 11 Menus: Choosing Commands 13 About Windows 15 Moving and Resizing Windows Closing and Opening Windows Multiple Windows 18 Scrolling 18

Chapter 2: Installing Minitab 22

Before Installation 22 Checking Disk Space 23 Installing Minitab 24

Chapter 3: Starting and Stopping Minitab 27

Opening Minitab 27 Menus 28 Windows 30 Quitting Minitab 32

Chapter 4: Sample Session 33

Case Study: Faculty Survey 34
Exploring an Existing Worksheet 34
Creating a New Variable 37
Describing a Variable Using Basic Statistics 38
Creating High-Resolution Graphs 41
Correlating Two Variables 44
Quitting Minitab 46

Part II Tutorials

Tutorial 1: Working with Data 51

Case Study: Nutrition 52 Viewing the Data Window 53 Moving Around the Data Worksheet 54 Using Menus 54 Entering Data 56 Alpha Data 58 Changing Column Widths 58 Naming the Columns 59 Saving Your Data 60 Retrieving Data 61 Manipulating Data with General Expressions 62 Copying a Column 66 Getting Help 67 Case Study: Consultant 69 Deleting and Inserting Rows 70 Deleting Columns 73 Copying Parts of a Column 73 Case Study: Teaching 76 Importing a Data File Created with a Word Processor 76 The Session Window 78 Switching to the Data Window 80 Minitab Command Summary 82 Review and Practice 84

Tutorial 2:

Summarizing, Transforming, and Manipulating Data 88

Mean, Median, and Round 89 Summarizing Columns 92 Listing Columns in the Session Window 94 Combining Data with the Stack Command 95 Coding Data 97 Ranking Data 99 Sorting Data 100
Separating Data with Unstack 102
Standardizing Data 103
Using the Info Widow 105
Printing the Record of Your Session 106
Printing from an Outfile 107
Printing a Selection from the Session
Window 110
Minitab Command Summary 113
Review and Practice 115

Tutorial 3:

Graphical Methods for Describing Data 118

Graphics Modes 119 Graphing Single Variables 119 Creating a Histogram 120 Creating a Dotplot 125 Creating a Stem-and-Leaf Diagram 128 Creating a Boxplot 131 Plotting One Variable Against Another 133 Creating a Scatter Plot 133 Minitab at Work: Forestry 134 Using Tags in Scatter Plots 137 Creating a Multiple Scatter Plot 139 Printing Graphs 140 Saving Graphs 142 Discarding Graphs 143 Minitab Command Summary 143 Review and Practice 144

Tutorial 4:

Numerical Methods for Describing Data 147

Describing Data 148
Other Descriptive Statistics 151
Converting Alpha Data to Numeric 152
Describing Data Separately for Each Value of a
By Variable 155
Calculating Frequencies 156
Covariance 160
Correlation 162
The History Window 163

CONTENTS xiii

Minitab Command Summary 165 Review and Practice 166

Tutorial 5: Distributions and Random Data 169

Case Study: Blood Types 170 Discrete Probability Functions 170 Cumulative Probability Distributions for Discrete Variables 175 Case Study: Genetics 170 Generating Random Data from Discrete Distributions 177 Minitab at Work: Public Safety 180 Case Study: Heights 181 Generating Random Data from a Continuous Distribution 181 Obtaining the Normal Probability Plot Using Normal Scores 183 Inverse Cumulative Functions for Continuous Distributions 186 Sampling from a Column 187 Minitab Command Summary 189 Review and Practice 191

Tutorial 6: Inference from One Sample 194

Case Study: Crowdedness 195
Testing μ When σ Is Known 196
Computing a Confidence Interval for μ When σ
Is Known 199
Case Study: Revenues 200

Testing μ When σ Is Unknown 201
Minitab at Work: Retailing 202
Computing a Confidence Interval for μ When σ
Is Unknown 203

Case Study: Election 203
Testing and Obtaining a Confidence Interval for a Population Proportion 204
Minitab Command Summary 207
Review and Practice 207

Tutorial 7: Inference from Two Samples 210

Testing the Difference Between Two

Population Means Using Two Independent Samples in Separate Columns 211
Case Study: Blood Pressure 213
Testing the Difference Between Two Population Means Using Two Independent Samples Stacked in a Single Column 213
Minitab at Work: Scientific Research 216
Testing the Difference Between Two Population Means Using Paired Samples 217

Case Study: Blood Clotting 217
Calculating a Confidence Interval for the
Difference Between Two Population Means
Using Paired Samples 220
Minitab Command Summary 222
Review and Practice 222

Tutorial 8: Comparing Population Means: Analysis of Variance 225

Case Study: Electronics 226
Comparing the Means of Several
Populations 227
Fitted and Residual Values 228
NScores and a Check for Normality 229
Checking for Constant Variance 231
Tukey Multiple Comparison Test 232
Comparing the Means of Several Populations with Responses in Separate Columns 233
Assessing the Effects of Two Factors on a Response 235

Case Study: Marketing 235
Minitab Command Summary 244
Review and Practice 245

Tutorial 9: Examining Linear Relationships Between Variables: Regression 248

Finding a Straight Line Fit to Data: Simple Linear Regression 249
Polynomial Regression Models 256
Multiple Linear Regression 257
Minitab at Work: Ecology 260
Stepwise Multiple Regression 261
Stepwise Selection 261
Forward Selection 263
Backward Elimination 265
Minitab Command Summary 267
Review and Practice 267

Tutorial 10: Analyzing Categorical Data 271

Comparing an Observed Distribution to a
Hypothetical Distribution 272
Case Study: Transistors 275
Testing the Relationship Between Two
Categorical Variables in a Contingency
Table 276
Testing the Relationship Between Two
Categorical Variables Using Raw Data 278
Minitab at Work: Education 281
Minitab Command Summary 284
Review and Practice 284

Tutorial 11: Analyzing Data with Nonparametric Methods 287

Checking a Sampling Process for Randomness with the Runs Test 288

Testing the Population Median 290

Comparing the Medians of Two
Populations 292

Case Study: Banking 292

Minitab at Work: Medical Diagnostics 293

Comparing the Centers of K Populations 295 Minitab Command Summary 298 Review and Practice 299

Tutorial 12: Statistical Process Control 302

Constructing an Xbar Chart 303
Constructing a Range Chart 305
Constructing an Individuals Chart 307
Constructing a Moving Range Chart 310
Constructing a Proportion Chart 311
Minitab Command Summary 314
Review and Practice 315

Tutorial 13: Time Series Analysis 317

Case Study: Environment 318
Plotting a Time Series 318
Checking the Autocorrelation and Partial Autocorrelation Plots 320
Transforming a Time Series 323
Box-Jenkins (ARIMA) Analysis of a Time Series 326
Minitab at Work: Stock Market 329
Forecasting Using ARIMA 330
Minitab Command Summary 333
Review and Practice 334

Tutorial 14:

Macros 336

Menu Commands and the Minitab Command
Language 337
Executing a Macro Several Times 344
Creating a Macro Using a Word Processor 346
Generalizing a Macro 350
Other Enhancements to Macros 353
Minitab Command Summary 359
Review and Practice 359

CONTENTS

Part III Exploring Data

Exploring Data: Other Data Sets 365
Exploring Data: Larger Data Sets 371
Data Sets Used in Tutorials and Exercises 380

Part IV Reference

Chapter 1: Special Topics 405

Data Editor 405
Dialog Boxes 408
Time-Saving Hints 411
Alpha Data 412
Minitab File Types 412
Importing and Exporting Data 416

Chapter 2: Command Reference 423

How to Use the Command Reference 423
The Menu 425
The File Menu 427
The Edit Menu 438
The Calc Menu 442
The Stat Menu 466
The Window Menu 518
The Graph Menu 522
The Editor Menu 536

Chapter 3: Minitab Command Language 540

Session Commands 540 Subcommands 540 Syntax Rules for Session Commands 541 Missing Values 541
#, Comment Symbol 542
&, Continuation Symbol 542
Session Commands Not Available Through
the Menus 542

Chapter 4: Macros 544

A Simple Example 544
How to Create Command Files 545
Looping Through Commands 545
Looping Through Columns 546
Conditional Execution and Nesting
Macro 546
Macros with a Variable Number of
Arguments 547
Interactive Macros 547
Using YESNO 547
Using ECHO 548

Appendix A Session Command / Menu Command Equivalents 549

Appendix B Operating Minitab on a Network 558

Appendix D Error Messages 571

Appendix E Student Edition Limits 573

Index 575

THE STUDENT EDITION OF MINITAB® 8 Statistical software...adapted for education

C4 CO	
C1-A C2 INTEREST MANIE 2.07 2.07	
FICC 2.40 3.36 ACC 2.64 3.67	
ACC 344 3.42 3.50 ACC 101 3.25 3.12	
5 HET 426 2.47 1.5 6 RRC 111 2.47 3.00 3.5	
7 HRT 111 3.17 2. 8 ART 211 3.60 3.	
9 HRT 485 2.50 ATH 155 2.92	

PART I

Getting Started