

Contents

| | |
|---|------------|
| About This Book | xv |
| About The Author | xix |
| Acknowledgments | xxi |
| Chapter 1: Designing Database Tables | 1 |
| Introduction | 2 |
| Database Design | 2 |
| Conceptual View | 2 |
| Table Definitions | 3 |
| Redundant Information | 3 |
| Normalization | 4 |
| Normalization Strategies | 5 |
| Column Names and Reserved Words | 7 |
| ANSI SQL Reserved Words..... | 8 |
| SQL Code..... | 8 |
| Data Integrity | 8 |
| Referential Integrity | 9 |
| Database Tables Used in This Book | 9 |
| CUSTOMERS Table | 9 |
| INVENTORY Table | 10 |
| INVOICE Table..... | 10 |
| MANUFACTURERS Table | 10 |
| PRODUCTS Table | 11 |
| PURCHASES Table | 11 |
| Table Contents | 12 |
| The Database Structure | 14 |
| Sample Database Tables | 14 |
| Summary | 21 |

| | |
|--|-----------|
| Chapter 2: Working with Data in PROC SQL | 23 |
| Introduction | 24 |
| Overview of Data Types..... | 24 |
| Numeric Data | 24 |
| Date and Time Column Definitions | 27 |
| Character Data..... | 28 |
| Missing Values and NULL | 28 |
| Arithmetic and Missing Data | 29 |
| SQL Keywords | 32 |
| SQL Operators and Functions | 35 |
| Comparison Operators..... | 35 |
| Logical Operators | 36 |
| Arithmetic Operators..... | 38 |
| Character String Operators and Functions..... | 40 |
| Summarizing Data | 58 |
| Predicates..... | 62 |
| Dictionary Tables | 72 |
| Dictionary Tables and Metadata | 72 |
| Displaying Dictionary Table Definitions | 74 |
| Dictionary Table Column Names | 75 |
| Accessing a Dictionary Table's Contents | 78 |
| Summary | 89 |
| Chapter 3: Formatting Output..... | 91 |
| Introduction | 92 |
| Formatting Output..... | 92 |
| Writing a Blank Line between Each Row | 92 |
| Displaying Row Numbers..... | 93 |
| Using the FORMAT= Column Modifier to Format Output | 96 |
| Concatenating Character Strings | 97 |
| Inserting Text and Constants between Columns | 99 |
| Using Scalar Expressions with Selected Columns | 101 |
| Ordering Output by Columns | 104 |
| Grouping Data with Summary Functions | 107 |
| Grouping Data and Sorting..... | 109 |

| | |
|---|------------|
| Subsetting Groups with the HAVING Clause | 110 |
| Formatting Output with the Output Delivery System | 112 |
| ODS and Output Formats..... | 113 |
| Sending Output to a SAS Data Set | 114 |
| Converting Output to Rich Text Format..... | 115 |
| Exporting Data and Output to Excel | 116 |
| Delivering Results to the Web | 118 |
| Summary | 119 |
| Chapter 4: Coding PROC SQL Logic | 121 |
| Introduction | 122 |
| Conditional Logic | 122 |
| SQL Code..... | 122 |
| SQL Code..... | 122 |
| SQL Code..... | 123 |
| SQL Code..... | 123 |
| CASE Expressions..... | 123 |
| Simple Case Expression | 124 |
| Searched CASE Expression..... | 137 |
| Case Logic versus COALESCE Expression | 142 |
| Assigning Labels and Grouping Data | 143 |
| Logic and Nulls | 146 |
| Interfacing PROC SQL with the Macro Language | 148 |
| Exploring Macro Variables and Values..... | 149 |
| Creating Multiple Macro Variables | 153 |
| Using Automatic Macro Variables to Control Processing..... | 156 |
| Building Macro Tools and Applications | 158 |
| Creating Simple Macro Tools..... | 158 |
| Cross-Referencing Columns | 158 |
| Determining the Number of Rows in a Table..... | 159 |
| Identifying Duplicate Rows in a Table | 160 |
| Summary | 161 |
| Chapter 5: Creating, Populating, and Deleting Tables | 163 |
| Introduction | 164 |
| Creating Tables | 164 |

| | |
|---|------------|
| Creating a Table Using Column-Definition Lists | 165 |
| Creating a Table Using the LIKE Clause | 169 |
| Deriving a Table and Data from an Existing Table | 170 |
| Populating Tables..... | 172 |
| Adding Data to a Table with a SET Clause | 173 |
| Adding Data to All of the Columns in a Row..... | 176 |
| Adding Data to Some of the Columns in a Row | 181 |
| Adding Data with a SELECT Query..... | 185 |
| Bulk Loading Data from Microsoft Excel | 186 |
| Integrity Constraints | 192 |
| Defining Integrity Constraints | 192 |
| Types of Integrity Constraints | 192 |
| Preventing Null Values with a NOT NULL Constraint | 192 |
| Enforcing Unique Values with a UNIQUE Constraint..... | 195 |
| Validating Column Values with a CHECK Constraint..... | 196 |
| Referential Integrity Constraints..... | 197 |
| Establishing a Primary Key..... | 198 |
| Establishing a Foreign Key | 199 |
| Displaying Integrity Constraints..... | 202 |
| Deleting Rows in a Table | 203 |
| Deleting a Single Row in a Table | 203 |
| Deleting More Than One Row in a Table..... | 204 |
| Deleting All Rows in a Table | 204 |
| Deleting Tables..... | 205 |
| Deleting a Single Table | 205 |
| Deleting Multiple Tables | 206 |
| Deleting Tables That Contain Integrity Constraints..... | 206 |
| Summary | 208 |
| Chapter 6: Modifying and Updating Tables and Indexes | 209 |
| Introduction | 210 |
| Modifying Tables | 210 |
| Adding New Columns..... | 210 |
| Controlling the Position of Columns in a Table..... | 212 |
| Changing a Column's Length | 214 |
| Changing a Column's Format..... | 218 |

| | |
|--|------------|
| Changing a Column's Label..... | 219 |
| Renaming a Column | 219 |
| Renaming a Table | 221 |
| Indexes | 222 |
| Designing Indexes | 224 |
| Cardinality..... | 225 |
| Index Selectivity..... | 225 |
| Defining Indexes | 227 |
| Creating a Simple Index..... | 228 |
| Creating a Composite Index..... | 228 |
| Preventing Duplicate Values in an Index..... | 229 |
| Modifying Columns Containing Indexes | 229 |
| Deleting (Dropping) Indexes | 229 |
| Updating Data in a Table | 230 |
| Summary | 232 |
| Chapter 7: Coding Complex Queries | 233 |
| Introduction | 234 |
| Introducing Complex Queries | 234 |
| Joins | 235 |
| Why Joins Are Important | 235 |
| Information Retrieval Based on Relationships | 235 |
| DATA Step Merges versus PROC SQL Joins..... | 236 |
| Types of Complex Queries..... | 236 |
| Demystifying Join Algorithms | 239 |
| Influencing Joins with a Little Magic | 239 |
| Cartesian Product Joins | 242 |
| Inner Joins | 242 |
| Equijoins | 243 |
| Non-Equijoins..... | 245 |
| Reflexive or Self Joins | 247 |
| Using Table Aliases in Joins..... | 249 |
| Performing Computations in Joins | 250 |
| Joins with Three Tables | 251 |
| Joins with More Than Three Tables | 253 |

| | |
|---|------------|
| Outer Joins..... | 255 |
| Left Outer Joins | 255 |
| Right Outer Joins | 258 |
| Full Outer Joins | 259 |
| Subqueries | 261 |
| Alternate Approaches to Subqueries | 261 |
| Passing a Single Value with a Subquery | 262 |
| Passing More Than One Row with a Subquery | 266 |
| Comparing a Set of Values | 267 |
| Correlated Subqueries | 269 |
| Set Operations..... | 271 |
| Rules for Set Operators | 271 |
| Set Operators and Precedence..... | 272 |
| Accessing Rows from the Intersection of Two Queries..... | 272 |
| Accessing Rows from the Combination of Two Queries | 274 |
| Concatenating Rows from Two Queries | 276 |
| Comparing Rows from Two Queries | 278 |
| Complex Query Applications | 280 |
| One-to-One, One-to-Many, Many-to-One, and Many-to-Many Relationships..... | 280 |
| Processing First, Last, and Between Rows for BY-and Groups..... | 285 |
| Determining the Number of Rows in an Input Table..... | 290 |
| Identifying Tables with the Most Indexes | 291 |
| Summary..... | 293 |
| Chapter 8: Working with Views | 295 |
| Introduction | 296 |
| Views—Windows to Your Data | 296 |
| What Views Aren't..... | 297 |
| Types of Views | 297 |
| Creating Views | 299 |
| Displaying a View's Contents | 300 |
| Describing View Definitions..... | 301 |
| Creating and Using Views in SAS | 302 |
| Views and SAS Procedures | 303 |
| Views and DATA Steps..... | 305 |
| Eliminating Redundancy..... | 307 |

| | |
|---|------------|
| Restricting Data Access—Security | 307 |
| Hiding Logic Complexities | 308 |
| Nesting Views | 310 |
| Updatable Views..... | 312 |
| Inserting New Rows of Data..... | 313 |
| Updating Existing Rows of Data | 317 |
| Deleting Rows of Data | 320 |
| Deleting Views | 321 |
| Summary | 322 |
| Chapter 9: Troubleshooting and Debugging | 323 |
| Introduction | 323 |
| The World of Bugs..... | 324 |
| The Debugging Process | 324 |
| Types of Problems | 326 |
| Troubleshooting and Debugging Techniques | 327 |
| Validating Queries with the VALIDATE Statement | 327 |
| Documented PROC SQL Options and Statement | 328 |
| Undocumented PROC SQL Options..... | 342 |
| Macro Variables | 343 |
| Troubleshooting and Debugging Examples..... | 345 |
| Summary | 350 |
| Chapter 10: Tuning for Performance and Efficiency..... | 351 |
| Introduction | 351 |
| Understanding Performance Tuning | 352 |
| Sorting and Performance | 352 |
| User-Specified Sorting (SORTPGM= System Options) | 353 |
| Automatic Sorting..... | 353 |
| Grouping and Performance..... | 354 |
| Splitting Tables..... | 354 |
| Indexes and Performance | 354 |
| Reviewing CONTENTS Output and System Messages | 355 |
| Optimizing WHERE Clause Processing with Indexes | 358 |
| Constructing Efficient Logic Conditions | 359 |
| Avoiding UNIONS | 361 |

| | |
|----------------------|------------|
| Summary | 365 |
| Index | 367 |