

# Contents

<b>About This Book .....</b>	<b>xv</b>
<b>About The Author .....</b>	<b>xix</b>
<b>Acknowledgments .....</b>	<b>xxi</b>
<b>Chapter 1: Designing Database Tables .....</b>	<b>1</b>
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

<b>Chapter 2: Working with Data in PROC SQL .....</b>	<b>23</b>
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
<b>Chapter 3: Formatting Output.....</b>	<b>91</b>
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
<b>Chapter 4: Coding PROC SQL Logic .....</b>	<b>121</b>
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
<b>Chapter 5: Creating, Populating, and Deleting Tables .....</b>	<b>163</b>
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
<b>Populating Tables.....</b>	<b>172</b>
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
<b>Integrity Constraints .....</b>	<b>192</b>
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
<b>Deleting Rows in a Table.....</b>	<b>203</b>
Deleting a Single Row in a Table .....	203
Deleting More Than One Row in a Table.....	204
Deleting All Rows in a Table .....	204
<b>Deleting Tables.....</b>	<b>205</b>
Deleting a Single Table .....	205
Deleting Multiple Tables .....	206
Deleting Tables That Contain Integrity Constraints.....	206
<b>Summary .....</b>	<b>208</b>
<b>Chapter 6: Modifying and Updating Tables and Indexes .....</b>	<b>209</b>
<b>Introduction .....</b>	<b>210</b>
<b>Modifying Tables .....</b>	<b>210</b>
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

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

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

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
<b>Chapter 9: Troubleshooting and Debugging .....</b>	<b>323</b>
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
<b>Chapter 10: Tuning for Performance and Efficiency.....</b>	<b>351</b>
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

<b>Summary .....</b>	<b>365</b>
<b>Index .....</b>	<b>367</b>