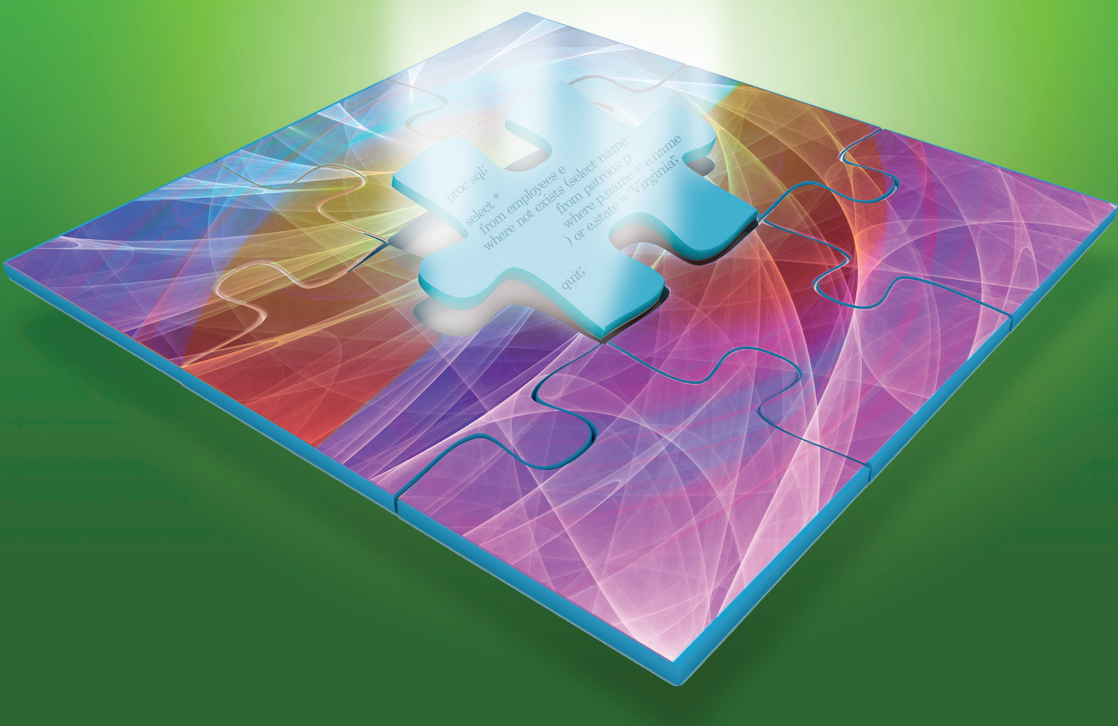
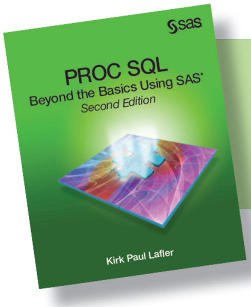
PROC SQL

Beyond the Basics Using SAS®

Second Edition



Kirk Paul Lafler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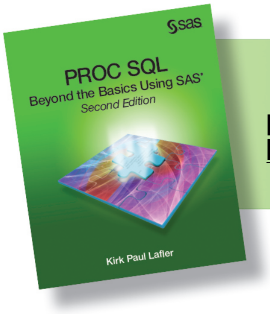


Chapter 1: Designing Database Tables

Introduction

The area of database design is very important in relational processes. Much has been written on this subject, including entire textbooks and thousands of technical papers. No pretenses are made about the thoroughness of this very important subject in these pages. Rather, an attempt is made to provide a quick-start introduction for those readers who are unfamiliar with the issues and techniques of basic design principles. Readers needing more information are referred to the references listed in the back of this book. As you read this chapter, the following points should be kept in mind.

Database Design

Activities related to good database design require the identification of end-user requirements and involve defining the structure of data values on a physical level. Database design begins with a *conceptual view* of what is needed. The next step, called *logical design*, consists of developing a formal description of database entities and relationships to satisfy user requirements. Seldom does a database consist of a single table. Consequently, tables of interrelated information are created to enable more complex and powerful operations on data. The final step, referred to as *physical design*, represents the process of achieving optimal performance and storage requirements of the logical database.

Conceptual View

The health and well-being of a database depends on its database design. A database must be in balance with all of its components (or optimized) to avoid performance and operation bottlenecks. Database design doesn't just happen and is not a process that occurs by chance. It involves planning, modeling, creating, monitoring, and adjusting to satisfy the endless assortment of user requirements without impeding resource requirements. Of central importance to database design is the process of planning. Planning is a valuable component that, when absent, causes a database to fall prey to a host of problems including poor performance and difficulty in operation. Database design consists of three distinct phases, as illustrated in Figure 1.1.

Figure 1.1: Three Distinct Phases of Database Design

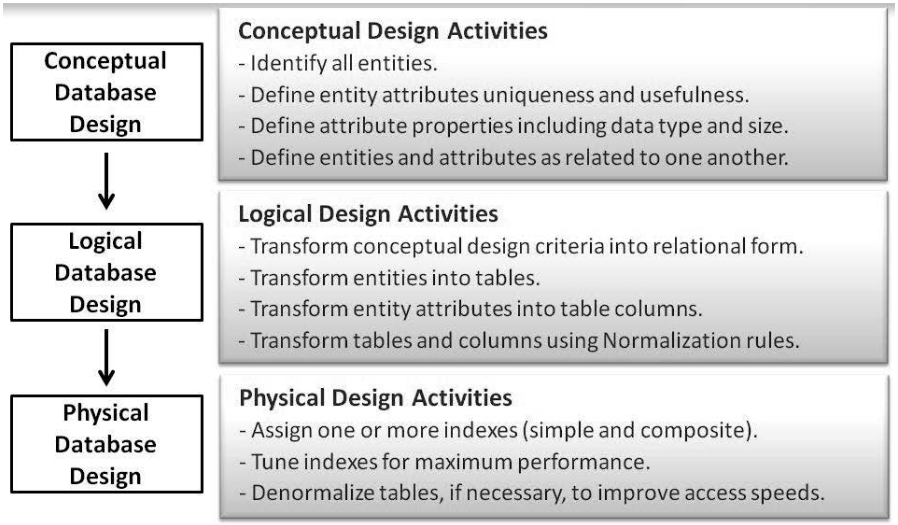


Table Definitions

PROC SQL uses a model of data that is conceptually stored as multisets rather than as physical files. A physical file consists of one or more records ordered sequentially or some other way. Programming languages such as COBOL and FORTRAN evolved to process files of this type by performing operations one record at a time. These languages were generally designed and used to mimic the way people process paper forms.

PROC SQL was designed to work with multisets of data. Multisets have no order, and members of a multiset are of the same type using a data structure known as a table. For classification purposes, a table is a base table consisting of zero or more rows and one or more columns, or a table is a virtual table (called a *view*), which can be used the same way that a table can be used (see Chapter 8, "Working with Views").

Redundant Information

One of the rules of good database design requires that data not be redundant or duplicated in the same database. The rationale for this conclusion originates from the belief that if data appears more than once in a database, then there is reason to believe that one of the pieces of data is likely to be in error. Furthermore, redundancy often leads to the following:

- Inconsistencies, because errors are more likely to result when facts are repeated.
- Update anomalies where the insertion, modification, or deletion of data may result in inconsistencies.

Another thing to watch for is the appearance of too many columns containing NULL values. When this occurs, the database is probably not designed properly. To alleviate potential table design issues, a process referred to as *normalizing* is performed. When properly done, this ensures the complete absence of redundant information in a table.

Normalization

The development of an optimal database design is an important element in the life cycle of a database. Not only is it critical for achieving maximum performance and flexibility while working with tables and data, it is essential to the organization of data by reducing or minimizing redundancy in one or more database tables. The process of table design is frequently referred to by database developers and administrators as *normalization*.

The normalization process is used for reducing redundancy in a database by converting complex data structures into simple data structures. It is carried out for the following reasons:

- To organize the data to save space and to eliminate any duplication or repetition of data.
- To enable simple retrieval of data to satisfy query and report requests.
- To simplify data manipulation requests such as data insertions, updates, and deletions.
- To reduce the impact associated with reorganizing or restructuring data as new application requirements arise.

The normalization process attempts to simplify the relationship between columns in a database by splitting larger multicolumn tables into two or more smaller tables containing fewer columns. The rationale for doing this is contained in a set of data design guidelines called *normal forms*. The guidelines provide designers with a set of rules for converting one or two large database tables containing numerous columns into a normalized database consisting of multiple tables and only those columns that should be included in each table. The normalization process consists of multiple steps with each succeeding step subscribing to the rules of the previous steps.

Normalization helps to ensure that a database does not contain redundant information in two or more of its tables. In an application, normalization prevents the destruction of data or the creation of incorrect data in a database. What this means is that information of fact is represented only once in a database, and any possibility of it appearing more than once is not, or should not be, allowed.

As database designers and analysts proceed through the normalization process, many are not satisfied unless a database design is carried out to at least third normal form (3NF). Joe Celko in his popular book *SQL for Smarties: Advanced SQL Programming* (Morgan Kaufman, 1999), describes 3NF this way: “Databases are considered to be in 3NF when a column is dependent on the key, the whole key, and nothing but the key.”

While the normalization guidelines are extremely useful, some database purists actually go to great lengths to remove any and all table redundancies even at the expense of performance. This is in direct contrast to other database experts who follow the guidelines less rigidly in an attempt to improve the performance of a database by only going as far as third normal form (or 3NF). Whatever your preference, you should keep this thought in mind as you normalize database tables. A fully normalized database often requires a greater number of joins and can adversely affect the speed of queries. Celko mentions that the process of joining multiple tables in a fully normalized database is costly, specifically affecting processing time and computer resources.

Normalization Strategies

After transforming entities and attributes from the conceptual design into a logical design, the tables and columns are created. This is when a process known as *normalization* occurs. Normalization refers to the process of making your database tables subscribe to certain rules. Many, if not most, database designers are satisfied when third normal form (3NF) is achieved and, for the objectives of this book, I will stop at 3NF, too. To help explain the various normalization steps, an example scenario follows.

First Normal Form (1NF)

First normal form (1NF) involves the elimination of data redundancy or repeating information from a table. A table is considered to be in first normal form when all of its columns describe the table completely and when each column in a row has only one value. A table satisfies 1NF when each column in a row has a single value and no repeating group information. Essentially, every table meets 1NF as long as an array, list, or other structure has not been defined. The following table illustrates a table satisfying the 1NF rule because it has only one value at each row-and-column intersection. The table is in ascending order by CUSTNUM and consists of customers and the purchases they made at an office supply store.

Table 1.1: First Normal Form (1NF) Table

CUSTNUM	CUSTNAME	CUSTCITY	ITEM	UNITS	UNITCOST	MANUCITY
1	Smith	San Diego	Chair	1	$179.00	San Diego
1	Smith	San Diego	Pens	12	$0.89	Los Angeles
1	Smith	San Diego	Paper	4	$6.95	Washington
1	Smithe	San Diego	Stapler	1	$8.95	Los Angeles
7	Lafler	Spring Valley	Mouse Pad	1	$11.79	San Diego
7	Loffler	Spring Valley	Pens	24	$1.59	Los Angeles
13	Thompson	Miami	Markers	.	$0.99	Los Angeles

Second Normal Form (2NF)

Second normal form (2NF) addresses the relationships between sets of data. A table is said to be in second normal form when all the requirements of 1NF are met and a foreign key is used to link any data in one table which has relevance to another table. The very nature of leaving a table in first normal form (1NF) may present problems due to the repetition of some information in the table. One noticeable problem is that Table 1.1 has repetitive information in it. Another problem is that there are misspellings in the customer name. Although repeating information may be permissible with hierarchical file structures and other legacy type file structures, it does pose a potential data consistency problem as it relates to relational data.

To describe how data consistency problems can occur, let's say that a customer takes a new job and moves to a new city. In changing the customer's city to the new location, it would be very easy to miss one or more occurrences of the customer's city resulting in a customer residing incorrectly in two different cities. Assuming that our table is only meant to track one unique customer per city, this would definitely be a data consistency problem. Essentially, second normal form (2NF) is important because it says that every non-key column must depend on the entire primary key.

Tables that subscribe to 2NF prevent the need to make changes in more than one place. What this means in normalization terms is that tables in 2NF have no partial key dependencies. As a result, our database that consists of a single table that satisfies 1NF will need to be split into two separate tables in order to subscribe to the 2NF rule. Each table would contain the CUSTNUM column to connect the two tables. Unlike the single table in 1NF, the tables in 2NF allow a customer's city to be easily changed whenever they move to another city because the CUSTCITY column only appears once. The tables in 2NF would be constructed as follows.

Table 1.2: CUSTOMERS Table

CUSTNUM	CUSTNAME	CUSTCITY
1	Smith	San Diego
1	Smithe	San Diego
7	Lafler	Spring Valley
13	Thompson	Miami

Table 1.3: PURCHASES Table

CUSTNUM	ITEM	UNITS	UNITCOST	MANUCITY
1	Chair	1	$179.00	San Diego
1	Pens	12	$0.89	Los Angeles
1	Paper	4	$6.95	Washington
1	Stapler	1	$8.95	Los Angeles
7	Mouse Pad	1	$11.79	San Diego
7	Pens	24	$1.59	Los Angeles
13	Markers	.	$0.99	Los Angeles

Third Normal Form (3NF)

Referring to the two tables constructed according to the rules of 2NF, you may have noticed that the PURCHASES table contains a column called MANUCITY. The MANUCITY column stores the city where the product manufacturer is headquartered. Keeping this column in the PURCHASES table violates the third normal form (3NF) because MANUCITY does not provide factual information about the primary key column (CUSTNUM) in the PURCHASES table. Consequently, tables are considered to be in third normal form (3NF) when each column is dependent on the key, the whole key, and nothing but the key. The tables in 3NF are constructed so the MANUCITY column would be in a table of its own as follows.

Table 1.4: CUSTOMERS Table

CUSTNUM	CUSTNAME	CUSTCITY
1	Smith	San Diego
1	Smithe	San Diego
7	Lafler	Spring Valley
13	Thompson	Miami

Table 1.5: PURCHASES Table

CUSTNUM	ITEM	UNITS	UNITCOST
1	Chair	1	$179.00
1	Pens	12	$0.89
1	Paper	4	$6.95
1	Stapler	1	$8.95
7	Mouse Pad	1	$11.79
7	Pens	24	$1.59
13	Markers	.	$0.99

Table 1.6: MANUFACTURERS Table

MANUNUM	MANUCITY
101	San Diego
112	San Diego
210	Los Angeles
212	Los Angeles
213	Los Angeles
214	Los Angeles
401	Washington

Beyond Third Normal Form

In general, database designers are satisfied when their database tables subscribe to the rules in 3NF. But, it is not uncommon for others to normalize their database tables to fourth normal form (4NF) where independent one-to-many relationships between primary key and non-key columns are forbidden. Some database purists will even normalize to fifth normal form (5NF) where tables are split into the smallest pieces of information in an attempt to eliminate any and all table redundancies. Although constructing tables in 5NF may provide the greatest level of database integrity, it is neither practical nor desired by most database practitioners.

There is no absolute right or wrong reason for database designers to normalize beyond 3NF as long as they have considered all the performance issues that may arise by doing so. A common problem that occurs when database tables are normalized beyond 3NF is that a large number of small tables are generated. In these cases, an increase in time and computer resources frequently occurs because small tables must first be joined before a query, report, or statistic can be produced.

Column Names and Reserved Words

According to the American National Standards Institute (ANSI), SQL is the standard language used with relational database management systems. The ANSI Standard reserves a number of SQL keywords from being used as column names. The SAS SQL implementation is not as rigid, but users should be aware of what reserved words exist to prevent unexpected and unintended results during SQL processing. Column names should conform to proper SAS naming conventions (as described in the *SAS Language Reference*), and they should not conflict with certain reserved words found in the SQL language. The following list identifies the reserved words found in the ANSI SQL standard.

ANSI SQL Reserved Words

AS	INNER	OUTER
CASE	INTERSECT	RIGHT
EXCEPT	JOIN	UNION
FROM	LEFT	UPPER
FULL	LOWER	USER
GROUP	ON	WHEN
HAVING	ORDER	WHERE

You probably will not encounter too many conflicts between a column name and an SQL reserved word, but when you do you will need to follow a few simple rules to prevent processing errors from occurring. As was stated earlier, although PROC SQL's naming conventions are not as rigid as other vendor's implementations, care should still be exercised, in particular when PROC SQL code is transferred to other database environments expecting it to run error free. If a column name in an existing table conflicts with a reserved word, you have three options at your disposal:

1. Physically rename the column name in the table, as well as any references to the column.
2. Use the RENAME= data set option to rename the desired column in the current query.
3. Specify the PROC SQL option DQUOTE=ANSI, and surround the column name (reserved word) in double quotes, as illustrated below.

SQL Code

```
PROC SQL DQUOTE=ANSI;
 SELECT *
  FROM RESERVED_WORDS
   WHERE "WHERE"='EXAMPLE';
QUIT;
```

Data Integrity

Webster's New World Dictionary defines *integrity* as "the quality or state of being complete; perfect condition; reliable; soundness." Data integrity is a critical element that every organization must promote and strive for. It is imperative that the data tables in a database environment be reliable, free of errors, and sound in every conceivable way. The existence of data errors, missing information, broken links, and other related problems in one or more tables can impact decision-making and information reporting activities resulting in a loss of confidence among users.

Applying a set of rules to the database structure and content can ensure the integrity of data resources. These rules consist of table and column constraints, and will be discussed in detail in Chapter 5, “Creating, Populating, and Deleting Tables.”

Referential Integrity

Referential integrity refers to the way in which database tables handle update and delete requests. Database tables frequently have a *primary key* where one or more columns have a unique value by which rows in a table can be identified and selected. Other tables may have one or more columns called a *foreign key* that are used to connect to some other table through its value. Database designers frequently apply rules to database tables to control what happens when a primary key value changes and its effect on one or more foreign key values in other tables. These referential integrity rules apply restrictions on the data that may be updated or deleted in tables.

Referential integrity ensures that rows in one table have corresponding rows in another table. This prevents lost linkages between data elements in one table and those of another enabling the integrity of data to always be maintained. Using the 3NF tables defined earlier, a foreign key called CUSTNUM can be defined in the PURCHASES table that corresponds to the primary key CUSTNUM column in the CUSTOMERS table. Users are referred to Chapter 5, “Creating, Populating, and Deleting Tables” for more details on assigning referential integrity constraints.

Database Tables Used in This Book

This section describes a database or library of tables that is used by an imaginary computer hardware and software wholesaler. The library consists of six tables: Customers, Inventory, Invoice, Manufacturers, Products, and Purchases. The examples used throughout this book are based on this library (database) of tables and are described and displayed below. An alphabetical description of each table used throughout this book appears below.

CUSTOMERS Table

The CUSTOMERS table contains customers that have purchased computer hardware and software products from a manufacturer. Each customer is uniquely identified with a customer number. A description of each column in the Customers table follows.

Table 1.7: Description of Columns in the Customers Table

CUSTNUM	Unique number identifying the customer.
CUSTNAME	Name of customer.
CUSTCITY	City where customer is located.

INVENTORY Table

The INVENTORY table contains customer inventory information consisting of computer hardware and software products. The Inventory table contains no historical data. As inventories are replenished, the old quantity is overwritten with the new quantity. A description of each column in the Inventory table follows.

Table 1.8: Description of Columns in the Inventory Table

PRODNUM	Unique number identifying product.
MANUNUM	Unique number identifying the manufacturer.
INVENQTY	Number of units of product in stock.
ORDDATE	Date product was last ordered.
INVENCST	Cost of inventory in customer's stock room.

INVOICE Table

The INVOICE table contains information about customers who purchased products. Each invoice is uniquely identified with an invoice number. A description of each column in the Invoice table follows.

Table 1.9: Description of Columns in the Invoice Table

INVNUM	Unique number identifying the invoice.
MANUNUM	Unique number identifying the manufacturer.
CUSTNUM	Customer number.
PRODNUM	Product number.
INVQTY	Number of units sold.
INVPRICE	Unit price.

MANUFACTURERS Table

The MANUFACTURERS table contains companies who make computer hardware and software products. Two companies cannot have the same name. No historical data is kept in this table. If a company is sold or stops making computer hardware or software, then the manufacturer is dropped from the table. In the event that a manufacturer has an address change, the old address is overwritten with the new address. A description of each column in the Manufacturers table follows.

Table 1.10: Description of Columns in the Manufacturers Table

MANUNUM	Unique number identifying the manufacturer.
MANUNAME	Name of manufacturer.
MANUCITY	City where manufacturer is located.
MANUSTAT	State where manufacturer is located.

PRODUCTS Table

The PRODUCTS table contains computer hardware and software products offered for sale by the manufacturer. Each product is uniquely identified with a product number. A description of each column in the Products table follows.

Table 1.11: Description of Columns in the Products Table

PRODNUM	Unique number identifying the product.
PRODNAME	Name of product.
MANUNUM	Unique number identifying the manufacturer.
PRODTYPE	Type of product.
PRODCOST	Cost of product.

PURCHASES Table

The PURCHASES table contains computer hardware and software products purchased by customers. Each product is uniquely identified with a product number. A description of each column in the Purchases table follows.

Table 1.12: Description of Columns in the Purchases Table

CUSTNUM	Unique number identifying the customer.
ITEM	Name of product.
UNITS	Number of items purchased by customer.
UNITCOST	Cost of product.

Table Contents

An alphabetical list of tables, variables, and attributes for each table is displayed below.

Output 1.1: Customers CONTENTS Output

Alphabetic List of Variables and Attributes				
#	Variable	Type	Len	Label
3	custcity	Char	20	Customer's Home City
2	custname	Char	25	Customer Name
1	custnum	Num	3	Customer Number

Output 1.2: Inventory CONTENTS Output

Alphabetic List of Variables and Attributes						
#	Variable	Type	Len	Format	Informat	Label
4	invencst	Num	6	DOLLAR10.2		Inventory Cost
2	invenqty	Num	3			Inventory Quantity
5	manunum	Num	3			Manufacturer Number
3	orddate	Num	4	MMDDYY10.	MMDDYY10.	Date Inventory Last Ordered
1	prodnum	Num	3			Product Number

Output 1.3: Invoice CONTENTS Output

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Label
3	custnum	Num	3		Customer Number
1	invnum	Num	3		Invoice Number
5	invprice	Num	5	DOLLAR12.2	Invoice Unit Price
4	invqty	Num	3		Invoice Quantity - Units Sold
2	manunum	Num	3		Manufacturer Number
6	prodnum	Num	3		Product Number

Output 1.4: Manufacturers CONTENTS Output

Alphabetic List of Variables and Attributes				
#	Variable	Type	Len	Label
3	manucity	Char	20	Manufacturer City
2	manuname	Char	25	Manufacturer Name
1	manunum	Num	3	Manufacturer Number
4	manustat	Char	2	Manufacturer State

Output 1.5: Products CONTENTS Output

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Label
3	manunum	Num	3		Manufacturer Number
5	prodcost	Num	5	DOLLAR9.2	Product Cost
2	prodname	Char	25		Product Name
1	prodnum	Num	3		Product Number
4	prodtype	Char	15		Product Type

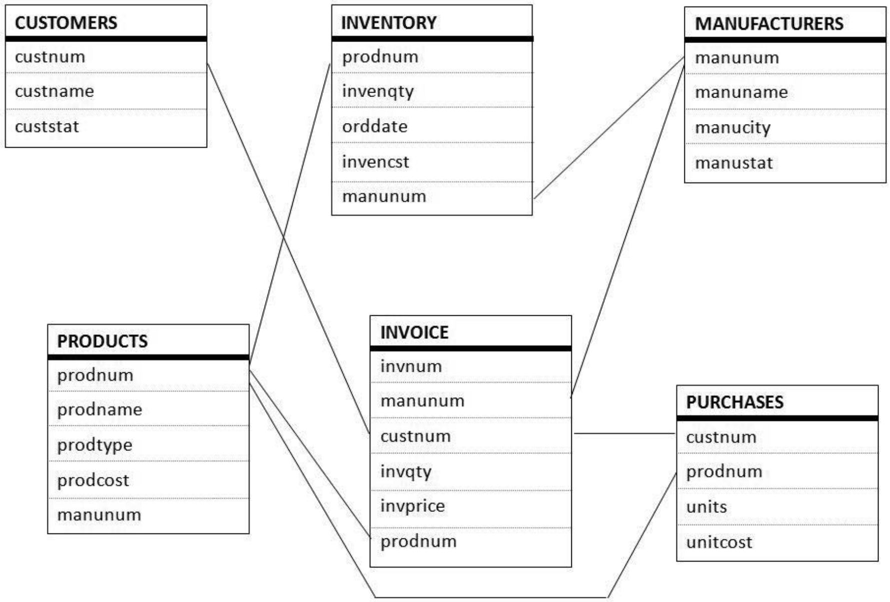
Output 1.6: Purchases CONTENTS Output

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Label
1	custnum	Num	4		Custnum
2	prodnum	Num	3		Prodnum
4	unitcost	Num	4	DOLLAR12.2	Unitcost
3	units	Num	3		Units

The Database Structure

The logical relationship between each table, and the columns common to each, appear below.

Figure 1.2. Logical Database Structure



Sample Database Tables

The following tables: Customers, Inventory, Manufacturers, Products, Invoice, and Purchases represent a relational database that will be illustrated in the examples in this book. These tables are small enough to follow easily, but complex enough to illustrate the power of SQL. The data contained in each table appears below.

Table 1.13: CUSTOMERS Table

Obs	custnum	custname	custcity
1	101	La Mesa Computer Land	La Mesa
2	201	Vista Tech Center	Vista
3	301	Coronado Internet Zone	Coronado
4	401	La Jolla Computing	La Jolla
5	501	Alpine Technical Center	Alpine
6	601	Oceanside Computer Land	Oceanside
7	701	San Diego Byte Store	San Diego
8	801	Jamul Hardware & Software	Jamul
9	901	Del Mar Tech Center	Del Mar
10	1001	Lakeside Software Center	Lakeside
11	1101	Bonsall Network Store	Bonsall
12	1201	Rancho Santa Fe Tech	Rancho Santa Fe
13	1301	Spring Valley Byte Center	Spring Valley
14	1401	Poway Central	Poway
15	1501	Valley Center Tech Center	Valley Center
16	1601	Fairbanks Tech USA	Fairbanks Ranch
17	1701	Blossom Valley Tech	Blossom Valley
18	1801	Chula Vista Networks	
N = 18			

Table 1.14: INVENTORY Table

Obs	prodnum	invenqty	orddate	invencst	manunum
1	1110	20	09/01/2000	$45,000.00	111
2	1700	10	08/15/2000	$28,000.00	170
3	5001	5	08/15/2000	$1,000.00	500
4	5002	3	08/15/2000	$900.00	500
5	5003	10	08/15/2000	$2,000.00	500
6	5004	20	09/01/2000	$1,400.00	500
7	5001	2	09/01/2000	$1,200.00	600
N = 7					

Table 1.15: INVOICE Table

Obs	invnum	manunum	custnum	invqty	invprice	prodnum
1	1001	500	201	5	$1,495.00	5001
2	1002	600	1301	2	$1,598.00	6001
3	1003	210	101	7	$245.00	2101
4	1004	111	501	3	$9,600.00	1110
5	1005	500	801	2	$798.00	5002
6	1006	500	901	4	$396.00	6000
7	1007	500	401	7	$23,100.00	1200
N = 7						

Table 1.16: MANUFACTURERS Table

Obs	manunum	manuname	manucity	manustat
1	111	Cupid Computer	Houston	TX
2	210	Global Comm Corp	San Diego	CA
3	600	World Internet Corp	Miami	FL
4	120	Storage Devices Inc	San Mateo	CA
5	500	KPL Enterprises	San Diego	CA
6	700	San Diego PC Planet	San Diego	CA
N = 6				

Table 1.17: PRODUCTS Table

Obs	prodnum	prodname	manunum	prodtype	prodcost
1	1110	Dream Machine	111	Workstation	$3,200.00
2	1200	Business Machine	120	Workstation	$3,300.00
3	1700	Travel Laptop	170	Laptop	$3,400.00
4	2101	Analog Cell Phone	210	Phone	$35.00
5	2102	Digital Cell Phone	210	Phone	$175.00
6	2200	Office Phone	220	Phone	$130.00
7	5001	Spreadsheet Software	500	Software	$299.00
8	5002	Database Software	500	Software	$399.00
9	5003	Wordprocessor Software	500	Software	$299.00
11	5004	Graphics Software	500	Software	$299.00
N = 10					

Table 1.18: PURCHASES Table

Obs	custnum	prodnum	units	unitcost
1	1701	1110	1	$3,200.00
2	101	5001	7	$299.00
3	701	5001	11	$299.00
4	701	5003	8	$299.00
5	701	5002	4	$399.00
6	701	5004	3	$299.00
7	701	1700	2	$3,400.00
8	701	1200	3	$3,300.00
9	701	1110	2	$3,200.00
10	1301	5001	3	$299.00
11	1301	5003	5	$299.00
12	1301	5002	2	$399.00
13	901	1700	2	$3,400.00
14	901	1200	3	$3,300.00
15	901	1110	5	$3,200.00
16	901	5001	9	$299.00
17	901	5002	5	$399.00
18	901	5003	8	$299.00
19	901	5004	2	$299.00
20	401	5001	11	$299.00

21	401	5002	5	$399.00
22	401	5003	7	$299.00
23	401	5004	3	$299.00
24	401	1700	3	$3,400.00
25	401	1200	6	$3,300.00
26	201	5001	6	$299.00
27	201	5001	6	$299.00
28	201	5003	9	$299.00
29	201	5002	4	$399.00
30	201	1700	3	$3,400.00
31	901	5001	2	$299.00
32	201	5001	2	$299.00
33	201	2102	5	$175.00
34	1101	2102	9	$175.00
35	1301	2102	11	$175.00
36	1401	2102	7	$175.00
37	801	2102	5	$175.00
38	501	2102	12	$175.00
39	301	2102	8	$175.00
40	1101	2200	3	$130.00
41	101	2102	9	$175.00

42	101	5003	3	$299.00
43	101	5004	2	$299.00
44	101	1200	3	$3,300.00
45	101	1700	5	$3,400.00
46	1301	1700	3	$3,400.00
47	1601	1700	7	$3,400.00
48	1801	1700	4	$3,400.00
49	1001	1700	5	$3,400.00
50	1101	1700	2	$3,400.00
51	1201	1200	8	$3,300.00
52	501	5001	3	$299.00
53	501	5003	5	$299.00
54	501	5004	1	$299.00
55	501	1700	4	$3,400.00
56	301	5001	6	$299.00
57	501	2102	9	$175.00
N = 57				

Summary

1. Good database design often improves the relative ease by which tables can be created and populated in a relational database and can be implemented into any database (see the "Conceptual View" section).
2. SQL was designed to work with sets of data and accesses a data structure known as a table or a "virtual" table, known as a view (see the "Table Definitions" section).
3. Achieving optimal design of a database means that the database contains little or no redundant information in two or more of its tables. This means that good database design calls for little or no replication of data (see the "Redundant Information" section).
4. Good database design avoids data redundancy, update anomalies, costly or inefficient processing, coding complexities, complex logical relationships, long application development times, and/or excessive storage requirements (see the "Normalization" section).
5. Design decisions made in one phase may involve making one or more tradeoffs in another phase (see the "Normalization" section).
6. A database in third normal form (3NF) is defined as a column that is dependent on the key, the whole key, and nothing but the key (see the "Normalization" section).

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About The Author

Kirk Paul Lafler is consultant and founder of Software Intelligence Corporation and has been using SAS since 1979. He is a SAS Certified Professional, provider of IT consulting services, trainer to SAS users around the world, and sasCommunity.org Advisory Board emeritus member. The author of 5 books, Kirk has written more than 500 papers and articles, been an invited speaker and trainer at 400-plus SAS users group conferences and meetings, and is the recipient of nearly two dozen "Best" contributed paper, hands-on workshop (HOW), and poster awards. For more than three decades he has supported the SAS users community by chairing the Southern California SAS Users Group (SoCalSUG), starting and chairing the San Diego SAS Users Group (SANDS), chairing and co-chairing academic sections at in-house, local, regional, and SAS Global Forum conferences, mentoring users, and contributing his popular SAS Tips column, "Kirk's Korner of Quick and Simple Tips," which appears regularly in several SAS Users Group newsletters and websites.

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