Application Programmer's Manual

MetaCube™ ROLAP Option

for Informix® Dynamic Server™

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Introduction

This manual contains information to assist you in using the Informix-MetaCube OLE automation programming interface to create custom applications.

Organization of This Manual

The chapters in this manual describe the classes of objects that together form the MetaCube programming interface. Each chapter contains information about one or more related classes of objects, including detailed descriptions of the properties and methods available for each class of object. This manual is designed as a reference manual. Programmers who are new to MetaCube should read this Introduction, Chapter 1, "Object-Oriented Programming and the MetaCube API," and Chapter 2, "Getting Started: MetaCube Tutorial." Refer to all other chapters in this manual as necessary. The manual consists of the following chapters:

- This Introduction provides an overview of the manual.
- Chapter 1, "Object-Oriented Programming and the MetaCube API," provides a very quick introduction to object-oriented programming, OLE Automation, Visual Basic for Applications, and the MetaCube programming interface.
- Chapter 2, "Getting Started: MetaCube Tutorial," provides an extensive tutorial that explains how to develop a sample application.
- Chapter 3, "The Metabase Class of Objects," describes the Metabase class of objects, which represent virtual multi-dimensional databases.
- Chapter 4, "The Dimension Class of Objects and Related Collections," describes the Dimension class of objects and its related classes of objects. The Dimension class and its related collections allow you to develop procedures that create, edit, or access MetaCube's metadata.

- Chapter 5, “Extensions,” describes the programming interface used to incorporate extensions compiled in C++ into MetaCube. This chapter also describes the functions created as extensions that are distributed with MetaCube.
- Chapter 6, “The FactTable Class of Objects and Related Collections,” describes the FactTable class of objects and its related classes of objects. The FactTable class and its related collections allow you to develop procedures that create, edit, or access MetaCube’s metadata.
- Chapter 7, “The Folders Class of Objects,” describes how to save query and filter definitions in folders.
- Chapter 8, “The Query and QueryBack Classes of Objects and Related Collections,” describe the properties and methods available for these two classes and their related collections.
- Chapter 9, “The Schema Class of Objects and Its Collections,” describes the Schema class of objects and its hierarchy of Table and Column collections.
- Chapter 10, “The User and DSSSystem Classes of Objects,” describes how user and DSSSystem objects can be manipulated to support the security features of MetaCube Secure Warehouse.
- Chapter 11, “The SystemMessage Class of Objects,” describes the SystemMessage class of objects, which allow you to distribute messages to users within an DSS System.
- Chapter 12, “The ValueList,”explains how to return multiple values into a development environment.
- Chapter 13, “OLE Requirements: the Application Class of Objects and Global Properties,” provides a brief explanation of the Application class of objects, the highest-level object class for any OLE software server.
- Chapter 14, “Scoping Rules,” explains rules for identifying objects with the same name but belonging to different parents or different classes.

Types of User

This manual is written for programmers who are developing custom MetaCube applications. You should be experienced with Object Linking and Embedding (OLE) and Visual Basic (VB). You should also be familiar with MetaCube Explorer.

Documentation

The text in this manual uses the following set of conventions.

Convention	Meaning
italics	Emphasized words appear in italics. Also used for the names of MetaCube components and some terms that are specific to MetaCube Explorer.
boldface	Used for code samples within tables. Also used when citing a particular property or method of an object class or when referring to a particular menu option.
`monospace`	Used for code samples.

Printed Documentation

Other printed manuals for the Informix-MetaCube product are:

- *MetaCube Explorer User's Guide*. This manual is written for people who are responsible for analyzing data about their company's business. It describes how to query the data warehouse in multi-dimensional terms to obtain meaningful reports that are the basis for timely business decisions.
- *MetaCube for Excel User's Guide***.** This manual is written for people who use Microsoft's Excel spreadsheet for business analysis. After adding MetaCube for Excel to the Excel software, the Excel user can query a data warehouse in multi-dimensional terms to obtain spreadsheet or PivotTable reports.

- *MetaCube Warehouse Manager's Guide*. This manual is written for the data warehouse administrator and describes how to specify internal information about the data warehouse so that the MetaCube components are able to access and graphically present the database for querying.
- *MetaCube SDK for Snap-Ins Programmer's Manual*. This manual is written for the C++ programmer who will write custom extensions for MetaCube Explorer and MetaCube for Excel. The MetaCube SDK for Snap-Ins product includes an Extension Wizard that generates skeletal C++ code, which can be modified to provide customized analysis functions.
- *MetaCube Installation and Configuration Guide*. This manual describes how to install and configure the MetaCube software components on both the server and on PCs.

Readme Files

In addition to the printed manuals, readme files are distributed with the Informix-MetaCube product. These files contain technical information, including last-minute changes to product capability or documentation. Please read these files, as they contain important information.

Related Reading

For more information about Informix SQL, refer to the following Informix manuals:

- *Informix Guide to SQL: Syntax*
- *Informix Guide to SQL: Reference*
- *Informix Guide to SQL: Tutorial*

For information on data warehousing, see *The Data Warehouse Toolkit*, by Ralph Kimball (John Wiley & Sons, Inc., 1996).

Compliance with Industry Standards

The American National Standards Institute (ANSI) has established a set of industry standards for SQL. Informix SQL-based products are fully compliant with SQL-92 Entry Level (published as ANSI X3.135-1992), which is identical to ISO 9075:1992, on Informix Dynamic Server. In addition, many features comply with the SQL-92 Intermediate and Full Level and X/Open C CAE (common applications environment) standards.

Informix SQL-based products are compliant with ANSI SQL-92 Entry Level (published as ANSI X3.135-1992) with the following exceptions:

- Effective checking of constraints
- Serializable transactions

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Chapter

1 Object-Oriented Programming and the MetaCube API

This chapter discusses object-oriented programming, OLE-Automation, Visual Basic for Applications, and the MetaCube programming interface, introducing six major classes of MetaCube objects.

OLE, OLE Automation, and MetaCube

OLE, or "Object Linking and Embedding," is an object technology developed by Microsoft Corporation to enable application developers to build and integrate component software. OLE is based on an advanced underlying object architecture called the OLE Component Object Model (COM), which is the basis of Microsoft's strategy to evolve the whole family of Windows operating systems into object-based operating systems and application environments. COM, the model on which OLE is built, is an underlying system software object model that allows complete inter-operability between software components developed by different vendors, even when those components are programmed in different languages.

In its original incarnation, OLE supported compound documents (for example, documents that included a spreadsheet from a different application), or drag and drop. We are primarily interested in *OLE Automation,* as this technology, and not standard OLE, allows developers to access MetaCube's full range of functionality from their own development environments.

OLE Automation has a misleading name, as it is unrelated to linking and embedding. OLE Automation is a mechanism that allows applications to expose their internal objects and the command sets that control and manipulate those objects to the operating system. Services can vary widely from application to application, but they are provided through a standard object interface.

For example, through OLE automation, you can activate a spreadsheet application, populate and format specific cells, and then deploy the spreadsheet's charting function to create a graph. This is possible even for users without programming experience, or programmers unfamiliar with the underlying OLE model.

Corporate developers, system integrators, and power-users can use traditional programming languages, development tools, and even productivity tools to access these capabilities. For example, a user could manipulate a spreadsheet using the standard macro language in his or her word processor.

This is a powerful technique, as it allows corporate developers and system integrators to quickly assemble larger, customized business solutions using packaged, component software as building blocks.

One such building block is MetaCube. MetaCube is implemented as an OLE automation server, so that all of its internal objects, such as queries and filters, are available for use by any application that supports OLE. Currently, all of the major development environments, including Visual Basic, C++, PowerBuilder, and SQLWindows, feature built-in support for OLE automation. In addition, several of the major productivity tools, including Microsoft Word, Excel, and Access, support OLE automation. Consequently, MetaCube can serve as the basis for high-performance, multi-dimensional access to your Data Warehouse, regardless of your development environment.

Introduction to Object-Oriented Programming

To leverage the MetaCube engine, you must first understand object-oriented programming. Object-oriented programming (OOP) encapsulates functionality within objects. Each object represents a set of properties; each property stores data defining the object. For example, a rectangle object may have properties such as its width, height, and position. These properties define the object.

To deploy an object, you must issue a *message* to that object, changing a property's value, or activating a *method*. The methods of an object define how that object accomplishes different tasks. Unlike procedural programming, in which properties are defined and methods executed independently, an object incorporates both properties and methods, which not only define an entity but also the operations that can be performed by, with, or on that entity.

For example, the rectangle object may include a method to move the rectangle. Rather than designing a separate procedure to re-position the rectangle, as you would in a procedural programming environment, you can issue a message to the rectangle object, which executes a standard method to move the rectangle. The procedure for moving a rectangle depends on the size and original position of the rectangle, as the rectangle essentially must be re-drawn. A rectangle object however, with properties of size and original position, may also include a method for moving itself, which you can activate by sending a message to the object.

Because an object's methods are self-contained, the object can be called from any development environment. Whereas the procedure for moving a rectangle differs from one language to another, the message issued to an object remains the same, regardless of the development environment. The movement of the rectangle object is a self-contained process.

Object Classes

There are, of course, an infinite number of rectangles with varying positions, sizes and shapes. Although we can discuss rectangles generally, and the properties that define rectangles, such as their position and shape, a program must define a particular rectangle, with a particular position and a particular shape. Each rectangle is a separate object, and all rectangle objects belong to the rectangle object class.

An object *class* represents a general type of object, and an *instance* of an object class is a particular object of that class's type. An instance of an object class is often simply referred to as an object. When developing an object-oriented application, you create or edit an instance of an object class, investing the general properties of its class with particular values. An object class may have, for example, a property such as color, whereas an instance of that object class may assign a value to that property, such as red, green, or blue.

Aside from its ODBC interface, MetaCube consists of a library of object classes created in C++. To develop MetaCube applications, you do not create new object classes. A MetaCube application simply issues messages, in the form of OLE-automation calls, to this library of object classes, instantiating objects, assigning values to their properties, and invoking their methods.

The relationship between object classes and an instance of an object class (or simply, an object) is analogous to the relationship between the type of car one owns – say, Ford – and the actual car itself, i.e. *my* Ford, with the dented fender and the fuzzy dice. Just as you can only drive an instance of the Ford class of cars, you can only program with an instance of an object class. The Ford class has properties, such as the speed at which it is driven, or the position of its rear view mirror, but those properties only acquire specific values when you drive an instance of a Ford, that is, an actual car, at a speed of thirty miles per hour, and a mirror tilt of twenty degrees.

Object Class Hierarchies and Collections

Object classes are organized hierarchically, with objects of the same class assembled in a *collection* belonging to a particular parent object. A collection of objects may partially define the parent object to which that collection belongs. For example, our Ford may own a collection of car door objects, each with different properties, such as their respective positions, and different methods, such as opening, closing, or rolling down a window. Together, this collection of doors partially defines the Ford. Each door, may in turn, own a collection of knobs or controls, such as a lock or a handle, that partially define the door. The MetaCube engine, like our example of the car, consists of a hierarchy of object classes. Each instance of most object classes own a collection containing instances of another object class. In fact, several collections of objects of different classes may belong to a single parent object.

A collection of objects is specified by identifying the parent of that collection, followed by the plural of the class name to which the objects in that collection belong:

```
MyFord.CarDoors
```

A dot separates the terms of this statement, in this case the name of the parent and the collection, respectively.

To determine how many objects exist within a collection, you can deploy the **Count** property, a general property of all collections returning the number an integer value. For our collection of car doors, for example, the Count property may represent a value of four, which we can display in a MsgBox, a Visual Basic for Applications object for displaying values that we use throughout this guide:

```
MsgBox MyFord.CarDoors.Count
```

To determine the names of objects within a collection, you can deploy the **Names** property, a general property of all collections that have objects with a Name property, such as Dimensions, Attributes, and DSSSystems. The Names property returns a ValueList containing the names of the objects in the collection:

```
    MsgBox MyFord.CarDoors.Names
```

To perform different operations upon items within any collection, you can invoke the methods summarized in Table 1-1.

Table 1-1 *General Methods of a Collection*

Method	**Description/Example**
Add	This method adds an instance of an object class to a collection. The arguments necessary, if any, depend on the properties of the added item. **Parent.Collection.Add Argument1, Argument2, Argument3...**
Item	This method identifies a particular instance or item within a collection by a sequentially-generated index number or by the name assigned to the instance. Once you have identified the item, you deploy one of that item's methods or properties. **Parent.Collection.Item(Index Number or Item Name).Action**
MakeFirst	This method and the two that follow re-arrange the order of items within a collection. This method in particular arranges the specified item as the first item in the collection, with a new index number of zero. You must identify the item by name or by its original index number. **Parent.Collections.MakeFirst "This Item"**
MakeLast	This method re-arranges items within a collection such that the specified item is the last item in the collection. You can identify this item by name or by its original index number. **Parent.Collections.MakeLast "This Item"**
MakeNth	This method assigns the specified item to a different location within the collection, with a new index number. You must identify the item to be moved by name or by its original index number, followed by its new index number. **Parent.Collections.MakeNth "This Item", 2**

Table 1-1 *General Methods of a Collection (continued)*

Method	**Description/Example**
Remove	This method removes an item from a collection; if the item does not exist in an over-lapping or over-arching collection, this method deletes the item. You must identify the item to be removed by name or by index number. If you are removing an object from the Extensions collection, you must refer to the item by index number. **Parent.Collection.Remove "This Item"**
RemoveAll	This method removes all items from a collection. **Parent.Collection.RemoveAll**
Swap	This method exchanges the positions of two elements in a collection. Since this method is commutative, you can identify the two items to swap by name or by index number, in either order. **Parent.Collection.Swap 1, 3**

Please note that while MetaCube's object classes are organized hierarchically, this hierarchy does not involve *inheritance*, as supported by development environments such as PowerSoft's PowerBuilder. Inheritance allows developers to invest an object with the properties of another object, in essence cloning that object. The new object can then be further developed, with its properties constituting a superset of the old object's properties. The OLE standard does not support inheritance.

In a MetaCube hierarchy, each class of objects is defined by a unique set of properties, which do not overlap. Extending our example of the car object illustrates the distinction: although a car object is in part defined by a collection of car door objects, the car and the car door have different sets of properties, with neither object encompassing the other object's properties as a subset of its own.

Figure 1-1 describes the major MetaCube object classes used to build and execute queries.

Figure 1-1
Simplified Representation of the Hierarchy of MetaCube Object Classes

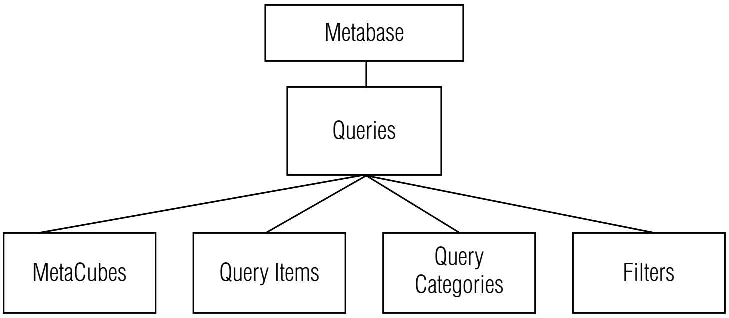


Figure 1-2 provides a complete view of all MetaCube object classes and their hierarchical relationships.

Figure 1-2
Complete MetaCube Class Hierarchy

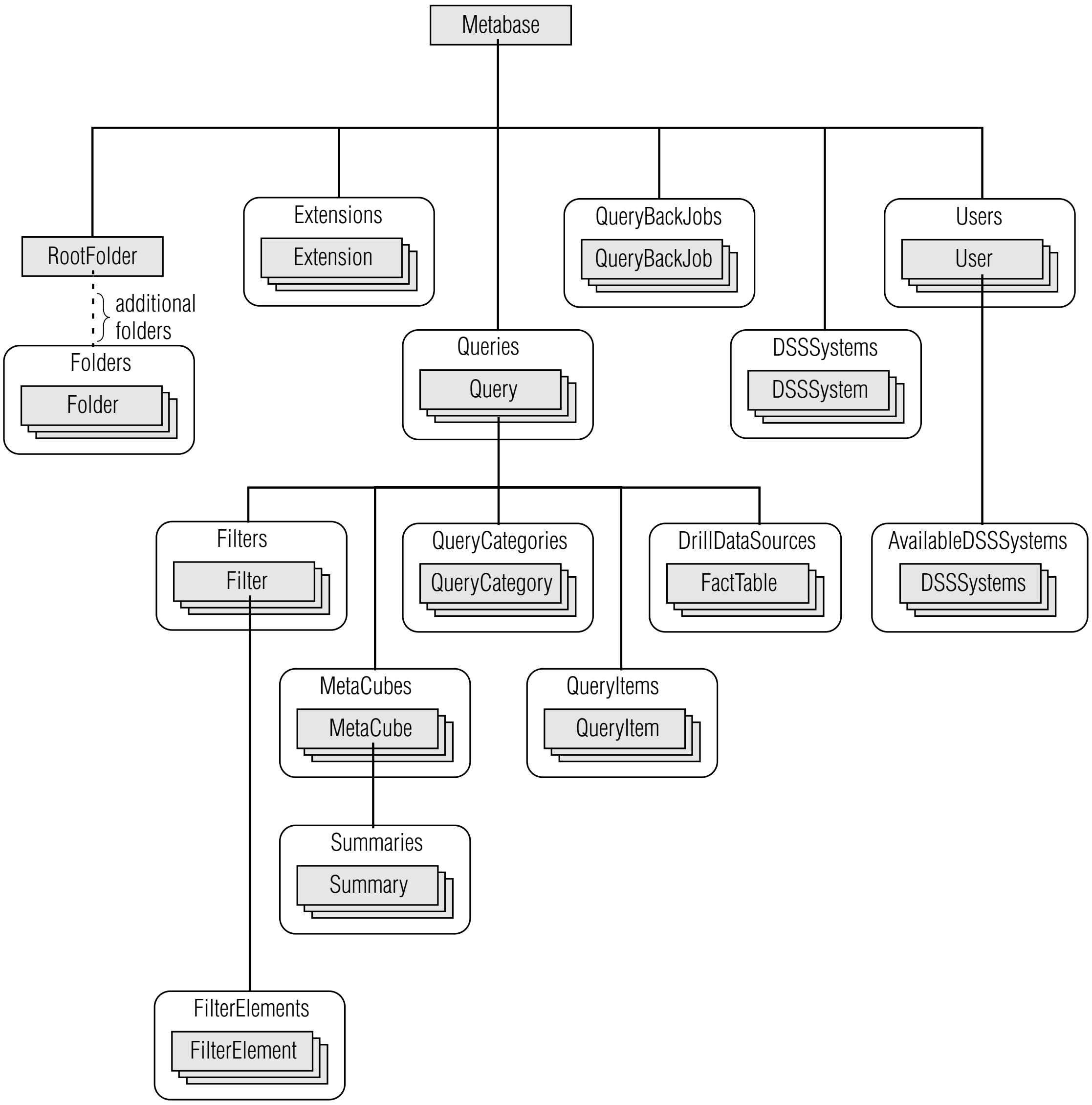
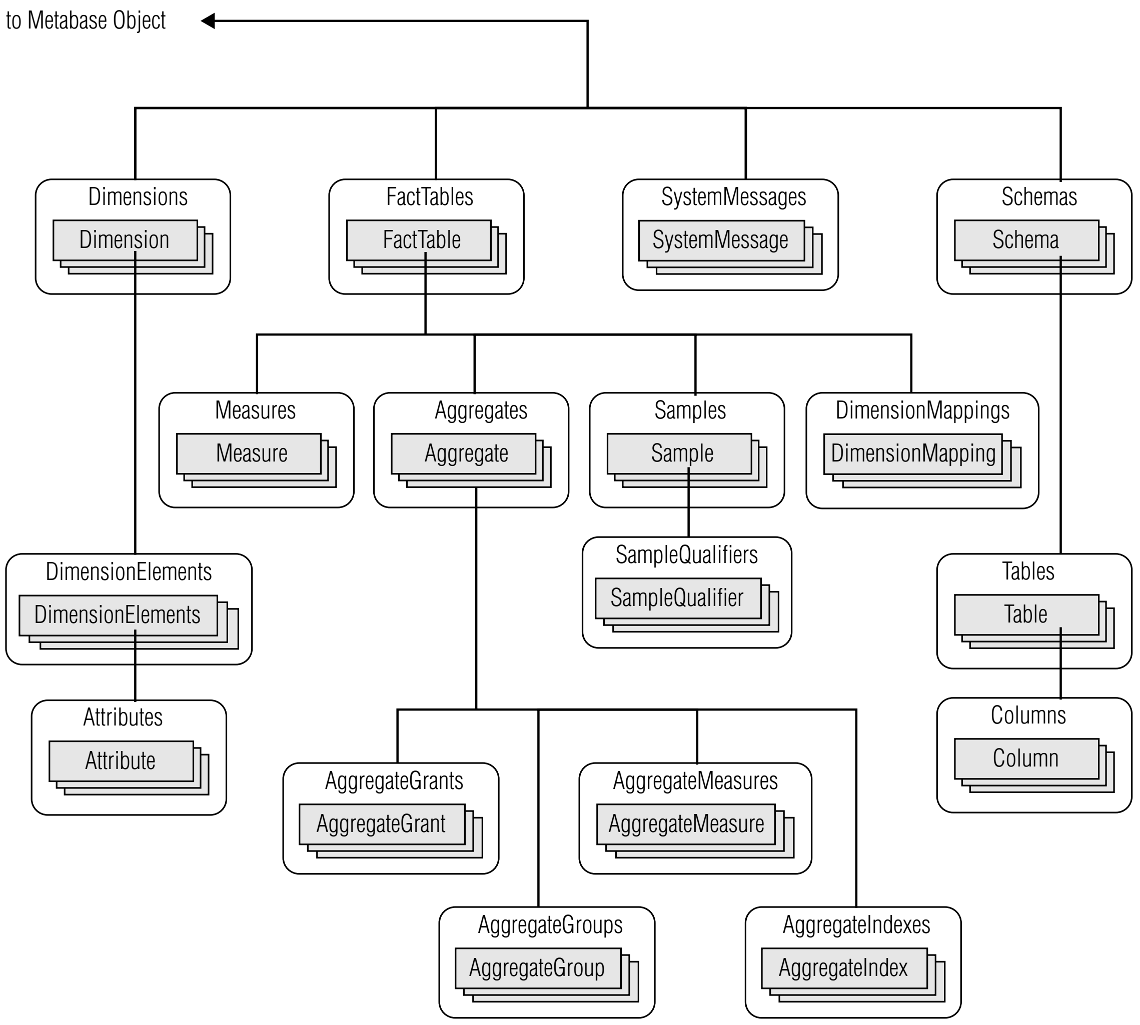


Figure 1-2 (continued)
Complete MetaCube Class Hierarchy



The Metabase class of objects stands at the top of MetaCube's hierarchy of object classes as the master object. Each instance of the Metabase class of objects represents a "virtual" multi-dimensional database (a "Metabase"), which offers a multi-dimensional view of tables in a relational database without actually storing data in a multi-dimensional format. The features of each Metabase will depend not only on the set of relational tables to which it corresponds but also on the metadata description of those tables. A complete metadata description of relational tables comprises a Decision Support Software System, or DSS System. Multiple descriptions of identical tables may exist, either for security purposes, or to accommodate different communities of users. Every MetaCube procedure begins by instantiating a Metabase object. A full discussion of the Metabase object begins on page 3-3.

If the MetaCube engine has not already been launched, instantiating a Metabase object launches the MetaCube engine. The engine remains running until the instantiation is released from memory, usually at the end of the procedure. Upon release of an instance of a Metabase object, the engine may close, depending on whether the engine was running prior to that object's instantiation.

Different development environments can recognize the Metabase class of objects as a MetaCube object class because MetaCube registers the Metabase object class in your operating system's OLE registry upon installation.

Every instantiation of a Metabase object implicitly creates collections of child objects, the principal of these being a collection of query objects. Although the collections are initially empty, this semantic distinction is important because once you have explicitly instantiated a Metabase object, instances of other objects can simply be added to their respective, pre-existing collections. Unlike the Metabase class of objects, these objects do not require an explicit function for instantiation.

Queries that retrieve data through the particular multi-dimensional structure represented by a Metabase object belong to the collection of queries owned by that object. Each query consists of:

- multi-dimensional attributes, which correspond to the "what, when, and where" components of the query
- measures, which correspond to the "how much" component of the query
- filters, which set conditions limiting the range of data retrieved for a query

- reports or, more precisely, multi-dimensional representations of a data set, which determine how the data retrieved for a query will be displayed

Consider a typical query that retrieves the number of units sold, by region and by brand, for the last two weeks and displays the result in a cross-tabular report. The measure of the query is units sold, the attributes are brand and region, the filter defines a range of two weeks, and the report is cross-tabular. These terms should be familiar to you from your experience with MetaCube Explorer and are documented more fully in the *MetaCube Explorer User's Guide*.

A different object class represents each component of the query's definition. If a query is defined by multiple components of the same type, multiple objects of the same type are instantiated and stored in that query's collection of objects of that type. A given query may be defined by one or more attributes, measures, filters, and reports, with objects of a given class comprising a collection belonging to the query object. Query components' object class names differ slightly from their common names, as identified above.

Table 1-2 describes the nomenclature for these four classes of objects.

Table 1-2 *Primary Collections of a Query Object*

Common Name	**Object Name**	**Function**
Attributes	QueryCategories	"What," "when," and "where" components of a query
Measures	QueryItems	"How much" component of a query
Filters	Filters	Defines range of data retrieved
Reports	MetaCubes	Defines format in which to display data

Declaring MetaCube Object Type Variables

Using MetaCube 4.0 and Visual Basic or Visual Basic for Applications, you can declare MetaCube-specific object type variables and then safely create new instances of the MetaCube object classes. This approach to creating objects yields multiple advantages, including faster processing time, type safety (Visual Basic will issue an error if it receives the wrong type of object), and function checking during the coding process. If your MetaCube system operates over a network using a middle tier, faster processing will be particularly apparent.

To declare object type variables in MetaCube, you must add a reference to the MetaCube type library (metacube.tlb) in your project's type library. Then use the **Dim** and **Set** statements. The **Dim** statement declares a variable that refers to an object. No actual object is created, however, until you use the **Set** statement with a **New** keyword. The following example illustrates how **Dim** is used to formally declare the variable MyMetabase as Metabase, and then a **Set** statement with the **New** keyword is used to create an instance of the Metabase object. Use the **New** keyword to create instances of a Metabase object only. To create instances of all other MetaCube objects, use the Add method for each class of object.

```
Dim MyMetabase as Metabase
Set MyMetabase = New Metabase
```

You may want to use object references to variables rather than creating an instance of the article itself. Because object references to variables are references to (rather than copies of) the object, any change in the object is reflected in all variables that refer to it. The following example illustrates how to assign an object reference to a variable for a Query object.

```
Dim MyQuery as MetaCubeLibrary.Query
Set MyQuery = MyMetabase.Queries.Add("first query")
```

In the example above, the Dim statement is used to fully qualify the object declaration. Because object types in different type libraries may have the same name, you should include "MetaCubeLibrary" in an object declaration to prevent ambiguity.

Notice that when making a new object reference to a Query object, parentheses enclose the name of the query added. When using the Set statement in Visual Basic or Visual Basic for Applications, you must remember to enclose parentheses around any arguments. Functions that return values to variables require parentheses around arguments, but procedures do not. Simply adding a query without assigning that query to a particular object reference executes a procedure, while assigning the query to an object reference performs a function.

Finally, to minimize the system resources consumed by object references, you should release all object references at the close of your application, particularly since running the application again would otherwise entail creating and setting object references still held in memory:

```
MyMetbase.Queries.Remove(MyQuery)
Set MyQuery = Nothing
Set MyMetabase = Nothing
```

By convention, the object references in this guide will be identified by the prefix “My,” followed by the class name of the object referenced. In practice, you can name your object variables however you like.

Compatibility

Object type variables are supported by Visual Basic 4.0, Visual Basic 5.0, and Excel 97. Note that Excel 95 does not support the use of object type variables.

Object Variables Used in MetaCube API Exercises

The MetaCube API exercises presented in this manual do not incorporate the use of object type variables. Instead they declare object variables, a programming technique supported by Visual Basic 4.0, Visual Basic 5.0, Excel 95, and Excel 97. The following example shows how an object variable is created in this manual’s exercises. In the example, an object variable, MyMetabase, is declared, and then an instance of an object of the Metabase class is stored in the object variable MyMetabase.

```
Dim MyMetabase as Object
Set MyMetabase = CreateObject("Metabase")
```

Visual Basic for Applications

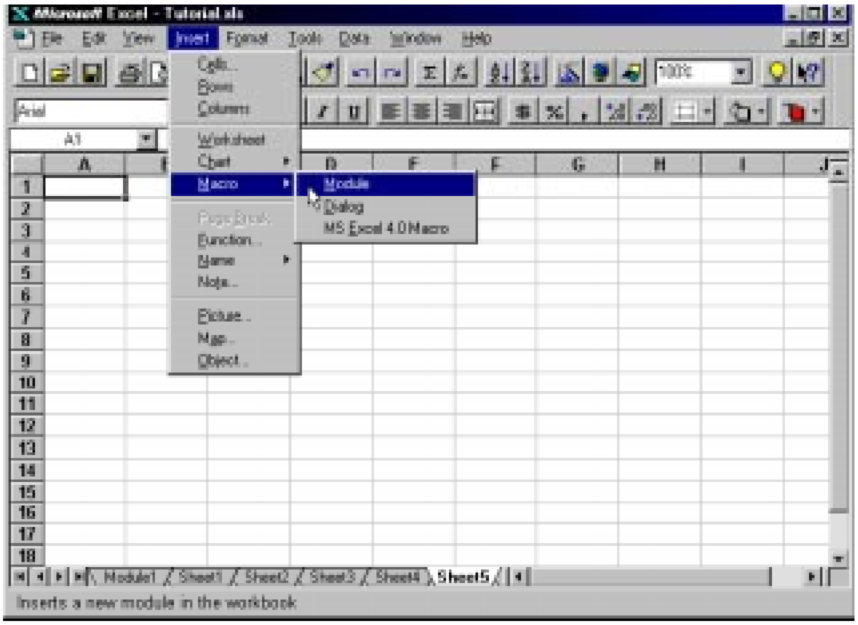
All examples in this text have been developed in Visual Basic for Applications (VBA), the macro language for Microsoft Excel, version 5.0 and later releases. Because most readers, regardless of their preferred development environment, have installed Microsoft Excel on their PCs, all examples use VBA syntax. For Visual Basic (VB) users, VBA offers another advantage, insofar as it is quite similar to VB and actually anticipates many of the new features incorporated into Visual Basic 4.0. Perhaps the most important distinction between VB and VBA is that, rather than storing code in text files, as VB does, VBA stores code in Excel's file format, as part of a workbook. For Microsoft Office '97 users, Excel may present a slightly different interface, which more completely resembles the Visual Basic development environment. To insert a macro module in an Excel '97 workbook, see the Excel documentation, as the actions described here only apply to Excel '95 and previous releases.

For developers familiar with PowerBuilder, SQLWindows, C++ or other OLE-automated development environments, VBA may seem to differ quite drastically from the language to which you are accustomed. While this may be true insofar as the syntax for beginning procedures, passing arguments, declaring variables, and displaying data will differ across development environments, the OLE-automation calls to the MetaCube engine will nonetheless remain more or less the same. Throughout this reference, the emphasis remains centered on MetaCube objects, with a minimum of VBA-specific functionality.

To develop a MetaCube application from Microsoft Excel, launch the application, and open a new workbook. A new workbook typically consists of six or more sheets, which you can access by clicking the tabs, labeled "Sheet1," "Sheet2," etc., that line the bottom of Excel's main window. Within each worksheet, you can deploy Excel's standard spreadsheet capabilities; you can also use a worksheet to display data retrieved by MetaCube.

To develop applications in VBA, you must insert a macro module, the site where you actually enter, edit, and view code. Applications developed in VBA must always be executed from a module, or by a keystroke, menu item, or toolbar item linked to a macro module. To insert a macro module, select **Macro** from the drop-down **Insert** menu; from the right pop-up menu that appears to the right, choose **Module**. See Figure 1-3.

Figure 1-3
Inserting A Macro Module


Microsoft Excel - Tutorial.xls
File Edit View Insert Format Tools Data Window Help
Cells...
Rows
Columns
Worksheet
Chart
Macro
Module
Dialog
MS Excel 4.0 Macro
Page Break
Function...
Name
Note...
Picture...
Map...
Object...
Module1 Sheet1 Sheet2 Sheet3 Sheet4 Sheet5
Inserts a new module in the workbook

A tab labeled "Module1" will appear to the right of the worksheet tabs at the bottom of Excel's main window. To begin entering code, click this tab, which opens the macro module.

You can also rename your macro module by right-clicking the module, and choosing **Rename** from the pop-up menu. Rename "Module1" as "MetaCube Code." By an identical method, rename two worksheets as "Define the Query," and "Query Report."

Once we have inserted a module, and given appropriate names to that module and several worksheets, we are ready to build a VBA application that makes OLE-automation calls to the MetaCube engine.

Chapter

2

Getting Started: MetaCube Tutorial

In this chapter you can develop a sample application involving many of the object classes, properties, methods, and programming techniques discussed throughout this text.

MetaCube in Thirteen Lessons: An API Tutorial

Before thoroughly reviewing each MetaCube object class and its methods, properties, and collections, many developers and power-users can gain a working understanding of MetaCube's application programming interface by developing a simple MetaCube query application.

Although MetaCube exposes objects that perform the work of Warehouse Manager, which maps the relational database as metadata, most custom-built applications will revolve around building and executing multi-dimensional queries, referencing metadata created in Warehouse Manager. Our discussion of MetaCube's objects will thus begin with the task of building multi-dimensional queries. Multi-dimensional queries, which the *Guide to MetaCube Explorer* discusses in greater detail, are defined by such natural business terms as time, product, and geography. As we have noted before, MetaCube can be thought of as a virtual multi-dimensional database, translating multi-dimensional queries into ANSI-standard SQL.

This tutorial begins by hard-coding a simple query. It then generates a report for that query and subsequently adds filtering, calculations, pivoting, and sorting features. Ultimately, the procedure populates list-boxes with the names of available attributes, measures, and saved filters, prompting the user to define the query in the terms listed. Each exercise adds to the body of code from the previous exercises, with the new material set off in bold font.

To begin, load Microsoft Excel, version 5.0 or later, and open the file “M3_API.XLS,” which installs in the MetaCube exercise directory. This workbook contains a set of named worksheets to which the exercises refer, and a module for each of the exercises in this tutorial. Create a new module to begin entering your own application code, or simply refer to existing modules as you read through the tutorial.

MetaCube API Exercise 1: The Metabase Object

As the logical representation of a multi-dimensional database, the Metabase object is MetaCube’s master object, similar to Excel’s Application object. Every MetaCube program begins by instantiating a Metabase object, storing that instantiation in an object variable. In VBA, the CreateObject function instantiates foreign objects, with the class name of the object passed as an argument to the function. Instantiating a Metabase object also requires an OLE-automation call to MetaCube, prompting the engine to launch. For the purpose of these exercises, you should launch the engine manually, from Windows, as your VBA application will otherwise be forced to load MetaCube each time your application runs.

Each Metabase object identifies a DSS System, which defines a particular multi-dimensional view of the relational database. Other properties assigned to the Metabase object typically correspond to other preferences and login information required in applications like MetaCube Explorer, such as the login, password, or host connection string. Once you have instantiated the Metabase object, and set certain Metabase properties, you can connect to the relational database, using the Connect method of the Metabase object.

```
Option Explicit 'All variables declared explicitly

Sub MetaCube_API()

'Declare Variables and Constants
    'Object Variables
    Dim MyMetabase As Object

'Instantiate Metabase: Log in to RDBMS, Open DSS System
    'Instantiate a Metabase object
    Set MyMetabase = CreateObject("Metabase")

    'Identify an ODBC data source
    Let MyMetabase.ConnectString = "Metademo"

    'Specify a set of metadata
    Let MyMetabase.Name = "MetaCube Demo"
```

```
13      'Specify login to database
14      Let MyMetabase.Login = "Metademo"
15      'Passes value to database on connection

16      'Specify database password
17      Let MyMetabase.Password = "Metademo"

18      'Log in to demonstration database, open DSS System
19      MyMetabase.Connect

20  End Sub
```

Explanation of MetaCube API Exercise 1

Line 1 contains an optional statement, Option Explicit, which requires you to declare explicitly any variables introduced by a procedure before using those variables. Enabling this option prevents VBA from mistaking a mis-identified variable for an entirely new variable, and thus quickly identifies typographical errors. The remainder of the line, demarcated by an apostrophe, is a comment. Although VBA ignores comments, most procedures cited in this text are heavily annotated for your benefit. As a rule, comments displayed in examples are formatted in italics, which are not necessary or available in VBA.

The procedure begins at line 2 with the “Sub” syntax, followed by the name of the procedure and any arguments passed to the procedure. Arguments are enclosed in parentheses. The empty set of parentheses signifies that no arguments have been passed to this procedure.

A single variable, MyMetabase, is declared at line 5 as an object type variable. A “dim” statement declares variables locally, within the scope of a procedure, whereas a “global” statement declares variables that are available to all modules in all workbooks. Global variables remain in memory until released, or until the workbook closes, and should be avoided when possible. Either syntax requires you to name the variable and allows you to specify its type, whether that be integer, string, object, long, etc. If you do not specify a variable’s type, VBA assumes it is of the variant type. For more information, see “Declaring MetaCube Object Type Variables” on page 1-14.

Line 8 instantiates an object of the Metabase class. The class of the object is passed as an argument to the CreateObject function, and the instance of the class is stored in the object variable MyMetabase. For a full discussion of the relationship between an object class and an instance of that class, see "Object Classes" on page 1-5. Please note that all object variables must be "set" equal to a value, as shown here, while other types of variables allow the optional "let" syntax.

Lines 10, 12, 14, and 17 assign different properties to the Metabase object MyMetabase. The ConnectString property identifies an ODBC data source. The Name property identifies the multi-dimensional map of the relational database by which MetaCube configures itself to retrieve data from the RDBMS. Each mapping is a DSS System, created in Warehouse Manager, or through a similar application developed through MetaCube's programming interface. The value specified for this property, the "MetaCube Demo" DSS System, is a demonstration system referred to throughout MetaCube documentation.

The Login and Password properties allow you to specify, respectively, the name of the user / schema to which you are logging in on the relational database and the password for that user / schema. Except for several specialized server-side processes, MetaCube relies on the already rigorous role-based security of the RDBMS.

Once you have provided the password and login information, you can connect to the relational database using the Connect method, as shown in line 14. Values for any unspecified Metabase properties are read from the metacube.ini file. For a complete list of Metabase properties, see "Metabase Properties" on page 3-5.

The procedure ends on line 20 with the syntax "End Sub," which automatically releases all locally-declared variables. Once the instantiation of the Metabase object has been released, MetaCube disconnects from the relational database. If you did not launch MetaCube manually, the release of the Metabase object ultimately closes the engine. This procedure thus disconnects without attempting to build a query. Once you have successfully connected, you are ready to modify this procedure to define a query.

To execute this procedure, position the cursor between the first and the last line of code, and press F5, or press the Play button on Excel's Visual Basic for Applications toolbar. To step through the procedure line-by-line, press F8.

Connection Information in the MetaCube API Exercises

To perform any of the exercises in this manual, you must first connect to the database and the MetaCube analysis engine. Lines 10 through 17 in MetaCube API Exercise 1 provide an example of the necessary connection information. Because MetaCube API Exercise 2 through MetaCube API Exercise 13 build on each other, connection information is repeated in each of those exercises. MetaCube API Exercise 14 through MetaCube API Exercise 24 do not follow an incremental pattern, however, and they do not all explicitly set connection information. Nonetheless, a connection must be established to execute any of those exercises, just as a connection is established in MetaCube API Exercise 1.

Note that default user connection properties can be set in MetaCube Secure Warehouse. You do not have to explicitly set Metabase.ConnectString or Metabase.Name (the DSS System name) if you have user properties defined in Secure Warehouse and you want those default connection properties to be used.

MetaCube API Exercise 2: Defining A Query

A collection of query objects belongs to each Metabase object, and, in turn, collections of attributes (QueryCategories), measures (QueryItems), filters, and reports belong to each query object. See Figure 1-1 on page 1-9. By instantiating a Metabase object such as MyMetabase, you implicitly create the collections that belong to an object of this class. Rather than using the CreateObject function to instantiate a Query object, for example, you can simply add an instance of a query to an existing collection of Query objects. To add an object to a collection, identify the object being added to the collection, provide the name of the collection itself (typically the plural of an object class, such as Queries or Filters), and use the Add method, a general method for adding an item to any collection.

Each procedure in this set of exercises builds on the first, adding several lines for each new exercise. The added lines are set off in bold font, and explained below. This exercise defines a query and displays the SQL generated by the MetaCube analysis engine in a message box. This exercise does not issue that SQL to the database.

```
1  Option Explicit 'All variables declared explicitly
2  Sub MetaCube_API()
```

```
3  'Declare Variables and Constants
4      'Object Variables
5      Dim MyMetabase As Object, _
6          MyQuery As Object
7      Const MyFirstAttribute = “Brand”
8      Const MyMeasure = “Units Sold”

9  'Instantiate Metabase: Log in to RDBMS, Open DSS System
10     'Instantiate a Metabase object
11     Set MyMetabase = CreateObject("Metabase")

12     'Identify an ODBC data source
13     Let MyMetabase.ConnectString = "Metademo"

14     'Specify a set of metadata
15     Let MyMetabase.Name = "MetaCube Demo"

16     'Specify login to database
17     Let MyMetabase.Login = "Metademo"
18     'Passes value to database on connection

19     'Specify database password
20     Let MyMetabase.Password = "Metademo"

21     'Log in to demonstration database, open DSS System
22     MyMetabase.Connect

23 'Define the Query
24 Set MyQuery = MyMetabase.Queries.Add("A New Query")
25 'Adds query to MyMetabase’s collection of queries

26 MyQuery.QueryCategories.Add MyFirstAttribute

27 'Add measure to MyQuery’s collection of measures
28 MyQuery.QueryItems.Add MyMeasure

29 'Display Query Definition
30 MsgBox MyQuery.SQL
31 'MetaCube generates SQL for query prior to execution

32 End Sub
```

Explanation of MetaCube API Exercise 2

We begin this exercise by declaring a second object variable, “MyQuery,” in line 6, which subsequently stores the newly-added instance of the Query class of objects. Please note that you can declare variables in a list, demarcating each new variable by a comma and individually specifying the type of each.

In anticipation of the arguments necessary to define our query, we also declare two constants in lines 7 and 8, using the syntax “Const,” followed by the name of the constant, the operator “=,” and the value it stores. One constant specifies a measure defined in the metadata, the other specifies an attribute defined in the metadata. If, within a DSS system, a measure name is repeated in another fact table, or if an attribute name is repeated across dimensions, you must provide a more specific definition of that component, identifying the exact measure or attribute desired, as described in “Scoping Rules” on page 14-3. Although we could specify the attribute and measure names directly in the query definition, declaring constants in a single location allows us to easily change our query definition.

Lines 9 through 22 connect MetaCube to the relational database, as discussed in MetaCube API Exercise 1 on page 2-4.

Lines 24 to 28 define a query by a single attribute and a single measure. Measures represent different types of numeric data associated with a transaction and corresponds to the “how much” component of a query. Attributes represent different ways of grouping those measures and correspond to the “what, when, and where” components of a query. Every query that retrieves numeric data must be defined by at least one attribute and one measure. An attribute is incorporated into a procedure as a QueryCategory, and a measure is incorporated into a query as a QueryItem. This section of the procedure defines a query requesting sales, grouped by brand, where “Units Sold” is the measure, and “Brand” is the attribute.

To define a query, we must instantiate an object of the Query class. Each Query object belongs to a collection of Query objects, all of which descend from an instance of the Metabase class of objects. To instantiate a Query object, we must identify a particular Metabase object’s query collection, and deploy the general Add method, as shown on line 24.

The name of the query appears as an argument at the end of this command. We enclose the argument in parentheses because we are returning this instance of the Query class of objects to an object variable, and functions require all arguments to be enclosed in parentheses. In Explorer, new queries are given such names as “Untitled1” until a user saves the query under a different name. Please note, however, that this application does not recognize your Query object by this name. This instance of the Query class of objects is stored in the object variable “MyQuery.”

Lines 26 and 28 refer to the “MyQuery” object variable as the parent of several collections. As shown in Figure 1-1 on page 1-9, each Query object owns collections of QueryCategory, QueryItem, Filter and MetaCube objects, which represent, respectively, attributes, measures, filters and reports. To generate SQL for a standard query, you must include at least one QueryCategory in a Query object’s collection of QueryCategories, and one QueryItem in a Query object’s collection of QueryItems.

Such collections are, of course, initially empty. Line 26 specifies MyQuery’s collection of QueryCategories, instantiating a QueryCategory object representing the “Brand” attribute within that collection. The name of the attribute appears as an argument at the end of this command. For MetaCube to understand this argument, we must have created metadata for the attribute of that name, describing which tables and columns correspond to this attribute. The same is true of measures, filters, and other logical objects.

Note that this instance of the QueryCategory object is not stored in an object variable, and any subsequent references to this object will identify this object by name or by index number as an item within the collection of QueryCategories owned by MyQuery. Because this command does not return a value, the constant representing the name of the attribute should not be enclosed in parentheses.

Line 28 identifies the measure included in this query definition, adding a QueryItem object to MyQuery’s collection of QueryItems. The name of the measure, as specified in your metadata, appears as an argument at the end of the command. A constant, “MyMeasure,” stores the name of the measure, “Units Sold.”

If you had mapped this measure to more than one fact table / data source, you would have included the name of the fact table when specifying the measure: “Sales Transactions.Units Sold.” If the measure corresponds to only one fact table, such specificity is unnecessary.

As was the case when instantiating a QueryCategory object, no variable stores this instance of the QueryItem class of objects and, consequently, we do not enclose this command’s arguments in parentheses.

Once we have satisfied the minimum requirements for a query definition, we can view the SQL commands MetaCube would generate to retrieve the data requested by the query from the relational database. Line 30 invokes the SQL property of the Query class of objects, which stores as a string the SQL generated for the query represented by MyQuery.

The Visual Basic for Applications MsgBox function displays this string expression in a dialog box. Please note that, as a query's definition becomes more complex, the MsgBox may not be able to contain the entire set of SQL commands generated for the query, and the definition will be cut off. A MsgBox cannot contain more than 1,024 characters, although the exact limit depends in large part on the width of the characters.

Once your application displays the SQL generated by the query, the application terminates on line 28. The next exercise executes the SQL on the relational database.

MetaCube API Exercise 3: Executing the Query, Displaying the Results

In this exercise, we execute the query defined in the previous exercise using the ToVBArray method and display the results using Excel's Range object.

```
 1  Option Explicit 'All variables declared explicitly

 2  Sub MetaCube_API()

 3  'Declare Variables and Constants
 4      'Object Variables
 5      Dim MyMetabase As Object, _
 6          MyQuery As Object, _
 7          MyMetaCube As Object

 8      'Excel Variables
 9      Dim ReportRange As Range

10      'Other Variables
11      Dim MyData As Variant

12      Const MyFirst Attribute = “Brand”
13      Const MyMeasure = “Units Sold”

14  'Instantiate Metabase: Log in to RDBMS, Open DSS System
15      'Instantiate a Metabase object
16      Set MyMetabase = CreateObject("Metabase")

17      'Identify an ODBC data source
18      Let MyMetabase.ConnectString = "Metademo"

19      'Specify a set of metadata
20      Let MyMetabase.Name = "MetaCube Demo"

21      'Specify login to database
22      Let MyMetabase.Login = "Metademo"
23      'Passes value to database on connection
```

```
    'Specify database password
    Let MyMetabase.Password = "Metademo"
    'Log in to demonstration database, open DSS System
    MyMetabase.Connect
'Define the Query
Set MyQuery = MyMetabase.Queries.Add("A New Query")
'Adds query to MyMetabase's collection of queries
MyQuery.QueryCategories.Add MyFirstAttribute
'Add measure to MyQuery's collection of measures
MyQuery.QueryItems.Add MyMeasure
'Display Query Definition
MsgBox MyQuery.SQL
'MetaCube generates SQL for query prior to execution
'Get Query Results, Define Report
'Add cube to MyQuery's cube collection
Set MyMetaCube = MyQuery.MetaCubes.Add("New Cube")
'Format data as an array VB can display, store in variable
Let MyData = MyMetaCube.ToVBArray
'The ToVBArray method implicitly requires MetaCube
'to execute the query on the relational database
'Clear "Query Report" Worksheet
Sheets("Query Report").Activate
Cells.Select
Selection.ClearContents
'Excel Code: Defines Range of Cells, Presents Data
Worksheets.Item("Query Report").Activate
Set ReportRange = _
    ActiveSheet.Range _
    (ActiveSheet.Cells(1, 1), _
    ActiveSheet.Cells _
    (MyMetaCube.Rows, MyMetaCube.Columns))
Let ReportRange.Value = MyData
ReportRange.EntireColumn.AutoFit 'Sizes columns
End Sub
```

Explanation of MetaCube API Exercise 3

This exercise executes the query defined in the previous exercise and displays the data in an Excel spreadsheet named “Query Report.” If you have not identified a sheet in your active workbook by this name, follow the procedure outlined on “Renaming Worksheets and Macro Modules” on page 1-18.

We begin this procedure by declaring three new variables in lines 7 through 13: MyMetaCube, MyData, and ReportRange. The MyMetaCube variable stores an instance of the MetaCube class of objects that represents a particular configuration for the data retrieved from the relational database. The MyData variable stores the data retrieved from the query in a two-dimensional variant array that Excel can display in a spreadsheet. The ReportRange variable is a special Excel-type variable that represents the range of cells in a spreadsheet that MetaCube requires to display the data.

To bypass the cumbersome task of declaring object variables, you can insert a file from the MetaCube library of training materials. Simply open the “M3_API.xls” workbook, select the tab labeled “Exercise #3,” and copy into your program the appropriate variable declarations.

Lines 14 to 27 establish a multi-dimensional connection to the relational database, and lines 28 to 37 define and display the query definition, as explained above. Line 39 instantiates a MetaCube object, which we compared in previous explanations to a report. More precisely, the MetaCube object represents the result set of a query, stored on the client as a virtual cube, on which you can readily perform operations. A Query object can own a collection of MetaCube objects, each defined to represent a query’s data in a different format.

We instantiate a MetaCube object using syntax similar to the commands for instantiating QueryCategory and QueryItem objects, as discussed in the previous example. After identifying the collection of MetaCube objects belonging to MyQuery, we can add a new instance of a MetaCube object to this collection, passing as an argument a name for this virtual cube of data. This name does not refer in any way to MetaCube’s metadata; like the query name argument, a MetaCube object’s name is simply another way of distinguishing an item in a collection. Because we will perform many operations on this virtual cube of data, we store this instantiation of the MetaCube object class in the object variable MyMetaCube. The command returns a value to an object variable and thus executes a function. Accordingly, the argument is enclosed in parentheses.

Instantiating the MetaCube object does not automatically execute the query on the relational database. To avoid premature execution of the query and to minimize client-server calls, MetaCube does not execute the query until the client application instructs MetaCube to perform some operation on the data. To explicitly command MetaCube to execute a query, use the Retrieve method of the Query class of objects.

Line 41, which invokes the ToVBArray method of the MetaCube class of objects, converts the data represented by the virtual cube to an array, a function that can only be performed when the data has actually been returned to the client. For this reason, the ToVBArray method implicitly requires MetaCube to execute the query defined in lines 28 to 33. The variant variable MyData stores this data, automatically becoming an array variable of the appropriate dimensions. Note that the "Let" syntax, though always unnecessary, is included throughout these exercises to emphasize the distinction between object variables and variables of other types.

Lines 45 to 56 activate a worksheet, define a range of cells into which you can import the array of data stored by the MyData variable, and assign the data in MyData to that range. The final line of this section adjusts the width of the report's columns so that none of the cells in the report are truncated. As most of the code in this section corresponds to Excel rather than the MetaCube programming interface, you can copy this section of code from the "Exercise #3" worksheet in the M3_API.xls workbook, which is located in the exercises subdirectory of your MetaCube directory.

The only syntax of particular interest to the MetaCube developer in this section is the continuation of line 50, which extends to line 54. Here, the Rows and Columns properties of the MetaCube class of objects, which represent the number of rows and columns in the data within the cube, delineate the range of cells to reserve for the report. Please note that, insofar as both properties depend on the nature and amount of data retrieved, both can require MetaCube to execute a query. In this case, however, the ToVBArray method on line 41 already triggered the query's execution.

MetaCube API Exercise 4: Filtering the Query

In this exercise we deploy the Filter object to limit the range of data retrieved by the query.

```
Option Explicit 'All variables declared explicitly

Sub MetaCube_API()

'Declare Variables and Constants
    'Object Variables
    Dim MyMetabase As Object, _
        FilterFolder as Object, _
        MyQuery As Object, _
        MyMetaCube As Object

    'Excel Variables
    Dim ReportRange As Range

    'Other Variables
    Dim MyData As Variant

    Const MyFirst Attribute = “Brand”
    Const MyMeasure = “Units Sold”
    Const MySavedFilter = “Boston”

'Instantiate Metabase: Log in to RDBMS, Open DSS System
    'Instantiate a Metabase object
    Set MyMetabase = CreateObject("Metabase")

    'Identify an ODBC data source
    Let MyMetabase.ConnectString = "Metademo"

    'Specify a set of metadata
    Let MyMetabase.Name = "MetaCube Demo"

    'Specify login to database
    Let MyMetabase.Login = "Metademo"
    'Passes value to database on connection

    'Specify database password
    Let MyMetabase.Password = "Metademo"

    'Log in to demonstration database, open DSS System
    MyMetabase.Connect

'Identify folder containing filters
Set FilterFolder = MyMetabase.RootFolder. _
    Folders.Item(“Public Filters”)

'Define the Query
Set MyQuery = MyMetabase.Queries.Add("A New Query")
'Adds query to MyMetabase’s collection of queries
```

```
MyQuery.QueryCategories.Add MyFirstAttribute
'Add measure to MyQuery’s collection of measures
MyQuery.QueryItems.Add MyMeasure

'Apply filter: specify filter name, who saved, and folder
MyQuery.Filters.AddSaved _
    MySavedFilter, “metapub”, FilterFolder

'Display Query Definition
MsgBox MyQuery.SQL
'MetaCube generates SQL for query prior to execution

'Get Query Results, Define Report
'Add cube to MyQuery’s cube collection
Set MyMetaCube = MyQuery.MetaCubes.Add("New Cube")

'Format data as an array VB can display, store in variable
Let MyData = MyMetaCube.ToVBArray
'The ToVBArray method implicitly requires MetaCube
'to execute the query on the relational database

'Clear "Query Report" Worksheet
Sheets("Query Report").Activate
Cells.Select
Selection.ClearContents

'Excel Code: Defines Range of Cells, Presents Data
Worksheets.Item("Query Report").Activate
Set ReportRange = _
    ActiveSheet.Range _
    (ActiveSheet.Cells(1, 1), _
    ActiveSheet.Cells _
    (MyMetaCube.Rows, MyMetaCube.Columns))
Let ReportRange.Value = MyData
ReportRange.EntireColumn.AutoFit 'Sizes columns

End Sub
```

Explanation of MetaCube API Exercise 4

This exercise applies a saved filter to the previously defined query, limiting the range of data retrieved to two four-week periods. Previously, the query had been completely unfiltered, returning brand sales for all dates recorded in the demonstration database. Now the query only returns the most recent thirteen weeks of brand sales. The format of the resulting report remains the same, but the numeric values within the report decrease, since the sales for all time are necessarily less than the sales for thirteen weeks.

Please note that, although Explorer and MetaCube for Excel require you to filter on time, such requirements are artificially imposed by these applications to prevent users from issuing unconstrained queries. The MetaCube engine allows you to submit for execution any query defined by valid measures, attributes, or even dimension elements.

The definitions of saved filters are stored in MetaCube's metadata. To access a saved filter, you must correctly identify the name of a filter associated with the DSS System you have opened, as well as the user name and folder under which that filter was saved. Security measures that prevent users of Explorer and MetaCube for Excel from accessing filters saved by other users do not apply, as this requirement too, is imposed by the application.

Line 15 declares a constant, “MySavedFilter,” which identifies the name of the filter saved in the metadata as “Boston.” This pre-defined, public filter installs with the demonstration database, limiting the data retrieved to the thirteen most current weeks recorded therein.

To access this filter in the demonstration database, we must identify the folder with which the Filter object is associated. MetaCube features a hierarchical folder interface for Query and Filter objects stored in the metadata tables of the relational database. Folders are descended from the RootFolder object, which is itself owned directly by the Metabase object. Each folder can, in turn, own sub-folders. Lines 31 and 32 store the “Public Filters” folder in the FilterFolder object variable. For a full description of folder functionality, see “The Folder Class of Objects” on page 7-3.

The procedure executes as before until line 40, which instantiates a Filter object as a member of MyQuery's collection of Filters. As illustrated in Figure 1-1 on page 1-9, each Filter object belongs to a collection owned by a particular Query object.

Each collection of Filter objects can consist of both new filters and saved filters. For this reason, you must specify one of two methods to instantiate a Filter object: AddSaved or AddNew. Instantiating a new Filter object with the AddNew method requires you to subsequently define the filter's components.

The AddSaved method simply requires three arguments, the name of the filter, the user who created the filter, and the folder under which it was saved. Each Metabase object owns a RootFolder, which in turn can own a collection of subdirectories or folders, providing a hierarchical interface for logical objects stored in MetaCube's metadata. For more information about folders, see "The Folder Class of Objects" on page 7-3. In this case, "MySavedFilter," represents the name of the saved filter, "metapub" identifies the user who defined this filter originally, and the RootFolder object, included here as an argument, indicates that the filter was originally saved in the root folder.

MetaCube API Exercise 5: Building A More Sophisticated Query, Pivoting

This exercise adds two attributes to the query's definition, displaying each value of one of the attributes in a separate column rather than in a separate row, as before.

```
Option Explicit 'All variables declared explicitly
Sub MetaCube_API()
'Declare Variables and Constants
    'Object Variables
    Dim MyMetabase As Object, _
        FilterFolder as Object, _
        MyQuery As Object, _
        MyMetaCube As Object
        MySummaryCategory As Object, _
        MySortCategory As Object, _
        MyPivotCategory As Object
    'Excel Variables
    Dim ReportRange As Range
    'Other Variables
    Dim MyData As Variant
    Const OrientationColumn = 2
    Const MyFirstAttribute = "Brand"
    Const MySecondAttribute = "Region"
    Const MyThirdAttribute = "Fiscal Week"
    Const MyMeasure = "Units Sold"
    Const MySavedFilter = "Boston"
'Instantiate Metabase: Log in to RDBMS, Open DSS System
    'Instantiate a Metabase object
    Set MyMetabase = CreateObject("Metabase")
    'Identify an ODBC data source
    Let MyMetabase.ConnectString = "Metademo"
    'Specify a set of metadata
    Let MyMetabase.Name = "MetaCube Demo"
    'Specify login to database
    Let MyMetabase.Login = "Metademo"
    'Passes value to database on connection
    'Specify database password
    Let MyMetabase.Password = "Metademo"
    'Log in to demonstration database, open DSS System
    MyMetabase.Connect
'Identify folder containing filters
Set FilterFolder = MyMetabase.RootFolder. _
    Folders.Item("Public Filters")
'Define the Query
Set MyQuery = MyMetabase.Queries.Add("A New Query")
'Adds query to MyMetabase's collection of queries
Set MySummaryCategory = _
    MyQuery.QueryCategories.Add(MyFirst Attribute)
Set MySortCategory = MyQuery.QueryCategories.Add _
    (MySecondAttribute)
Set MyPivotCategory = _
    MyQuery.QueryCategories.Add(MyThirdAttribute)
'Pivot this attribute to the column orientation
Let MyPivotCategory.Orientation = OrientationColumn
'Add measure to MyQuery's collection of measures
MyQuery.QueryItems.Add MyMeasure
'Apply filter: specify filter name, who saved, and folder
MyQuery.Filters.AddSaved _
    MySavedFilter, "metapub", FilterFolder
'Display Query Definition
MsgBox MyQuery.SQL
'MetaCube generates SQL for query prior to execution
'Get Query Results, Define Report
'Add cube to MyQuery's cube collection
Set MyMetaCube = MyQuery.MetaCubes.Add("New Cube")
'Format data as an array VB can display, store in variable
Let MyData = MyMetaCube.ToVBArray
'The ToVBArray method implicitly requires MetaCube
'to execute the query on the relational database
```

```
65 'Clear "Query Report" Worksheet
66 Sheets("Query Report").Activate
67 Cells.Select
68 Selection.ClearContents

69 'Excel Code: Defines Range of Cells, Presents Data
70 Worksheets.Item("Query Report").Activate
71 Set ReportRange = _
72     ActiveSheet.Range _
73     (ActiveSheet.Cells(1, 1), _
74     ActiveSheet.Cells _
75     (MyMetaCube.Rows, MyMetaCube.Columns))
76 Let ReportRange.Value = MyData
77 ReportRange.EntireColumn.AutoFit 'Sizes columns

78 End Sub
```

Explanation of MetaCube API Exercise 5

In this procedure we add two attributes to our query definition, one of which is pivoted to columns. Each value of an attribute organized by columns defines a separate column in the resulting report. By default, all attributes are organized by rows.

As always, we begin by declaring any new variables and constants. Because we will perform subsequent operations on both the existing QueryCategory object as well the newly instantiated QueryCategory objects, it is convenient to store each instantiation in a new object variable, declared as MySummary-Category, MySortCategory, and MyPivotCategory in lines 9 through 11. In lines 18 and 19, we declare two additional constants, both of which refer to attributes defined in MetaCube's metadata. As before, declaring constants allows us to change one of the parameters of a query simply by changing the constant declaration, as opposed to replacing every reference to that attribute in the code that follows.

Line 16 also declares a constant, but for a different reason. Many MetaCube commands require numeric arguments whose significance, while fully documented in this reference, are not immediately clear. Substituting an aptly-named constant for the rather cryptic numeric argument can render your code more readable, and easier to debug. In this exercise, a numeric argument, 2, specifies an orientation by columns, which we substitute with the constant, "OrientationColumn" whenever the argument is called for.

A complete list of this and similar constant declarations is provided in the file, “METACONS.BAS,” which installs in your MetaCube directory. Constant declarations for C++ developers can be found in “METACONS.H,” in the same directory. The names of these constants are included in all documentation references to MetaCube’s numeric arguments. The set of constant and variable declarations for this particular exercise can be copied from the tab labeled “Exercise #5” in the M3_API.xls workbook.

Line 42 modifies the code instantiating the first QueryCategory, now storing the object in the object variable MySummaryCategory. As a consequence of returning a value to an object variable, the argument for this QueryCategory must be enclosed in parentheses. Lines 44 through 47 add a second and a third attribute to the query definition, instantiating QueryCategory objects in exactly the same manner as MySummaryCategory.

As defined, the query now consists of three attributes: Brand, Region, and Fiscal Week, all of which would normally be organized in rows and sub-rows, depending on their order of instantiation.

To organize an attribute by columns, we must assign a numeric value to the Orientation property of the QueryCategory object, as shown on line 49. Assigning a new value to the Orientation property of the QueryCategory object after the query has processed would require us to instantiate a new MetaCube object, but does involve re-querying the database. The value assigned to the Orientation property specifies the configuration of the Query-Category, where 2 corresponds to pivoting by column, and 3 by page. In this example, the constant OrientationColumn substitutes for 2, an argument that is practically indecipherable without a reference. The resulting report will display, by default, brands and regions in rows, and weeks in columns. In an upcoming exercise, we compare each column of data with its predecessor, calculating the difference between the two.

MetaCube API Exercise 6: Sorting by an Attribute

In this exercise we organize the values of an attribute in reverse-alphabetical order.

```
Option Explicit 'All variables declared explicitly

Sub MetaCube_API()

'Declare Variables and Constants
    'Object Variables
    Dim MyMetabase As Object, _
        FilterFolder as Object, _
        MyQuery As Object, _
        MyMetaCube As Object
        MySummaryCategory As Object, _
        MySortCategory As Object, _
        MyPivotCategory As Object

    'Excel Variables
    Dim ReportRange As Range

    'Other Variables
    Dim MyData As Variant

    Const OrientationColumn = 2
    Const SortDirectionDesc = 2

    Const MyFirstAttribute = “Brand”
    Const MySecondAttribute = “Region”
    Const MyThirdAttribute = “Fiscal Week”
    Const MyMeasure = “Units Sold”
    Const MySavedFilter = “Boston”

'Instantiate Metabase: Log in to RDBMS, Open DSS System
    'Instantiate a Metabase object
    Set MyMetabase = CreateObject("Metabase")

    'Identify an ODBC data source
    Let MyMetabase.ConnectString = "Metademo"

    'Specify a set of metadata
    Let MyMetabase.Name = "MetaCube Demo"

    'Specify login to database
    Let MyMetabase.Login = "Metademo"
    'Passes value to database on connection

    'Specify database password
    Let MyMetabase.Password = "Metademo"

    'Log in to demonstration database, open DSS System
    MyMetabase.Connect
```

```
'Identify folder containing filters
Set FilterFolder = MyMetabase.RootFolder. _
    Folders.Item(“Public Filters”)

'Define the Query
Set MyQuery = MyMetabase.Queries.Add("A New Query")
'Adds query to MyMetabase’s collection of queries

Set MySummaryCategory = _
    MyQuery.QueryCategories.Add(MyFirst Attribute)

Set MySortCategory = MyQuery.QueryCategories.Add _
    (MySecondAttribute)
'Sort attribute values in reverse-alphabetical order
Let MySortCategory.SortDirection = _
    SortDirectionDesc

Set MyPivotCategory = _
    MyQuery.QueryCategories.Add(MyThirdAttribute)
'Pivot this attribute to the column orientation
Let MyPivotCategory.Orientation = OrientationColumn

'Add measure to MyQuery’s collection of measures
MyQuery.QueryItems.Add MyMeasure

'Apply filter: specify filter name, who saved, and folder
MyQuery.Filters.AddSaved _
    MySavedFilter, “metapub”, FilterFolder

'Display Query Definition
MsgBox MyQuery.SQL
'MetaCube generates SQL for query prior to execution

'Get Query Results, Define Report
'Add cube to MyQuery’s cube collection
Set MyMetaCube = MyQuery.MetaCubes.Add("New Cube")

'Format data as an array VB can display, store in variable
Let MyData = MyMetaCube.ToVBArray
'The ToVBArray method implicitly requires MetaCube
'to execute the query on the relational database

'Clear "Query Report" Worksheet
Sheets("Query Report").Activate
Cells.Select
Selection.ClearContents
```

```
73 'Excel Code: Defines Range of Cells, Presents Data
74 Worksheets.Item("Query Report").Activate
75 Set ReportRange = _
76     ActiveSheet.Range _
77     (ActiveSheet.Cells(1, 1), _
78     ActiveSheet.Cells _
79     (MyMetaCube.Rows, MyMetaCube.Columns))
80 Let ReportRange.Value = MyData
81 ReportRange.EntireColumn.AutoFit 'Sizes columns

82 End Sub
```

Explanation of MetaCube API Exercise 6

Sorting allows you to set the order in which the values of an attribute or a measure appear in a report. MetaCube can sort string values alphabetically and numbers from large to small, or vice-versa. By default a report is sorted by the values of the attributes organized in rows and columns, in ascending order. Attributes organized by sub-rows and sub-columns are sorted after attributes organized by rows and columns are sorted, and only within each grouping.

Because each record consists of both attributes and measures, you cannot simultaneously sort on attributes organized by row and on measures. MetaCube automatically sorts attributes organized by row in ascending order and does not sort measures by default. Any sort which you apply on measures is likely to change the format of the report.

You can reverse the order of a sort on a QueryCategory by changing the value of that object's SortDirection property. To sort on a column of numeric data in a report, you must assign a value to the SortColumn property of the MetaCube object, as documented in "Sorting: SortDirection and SortColumn Property" on page 8-49.

As a substitute for the cryptic values stored by both properties, we declare an intuitively-named constant in line 17, SortDirectionDesc, assigning it a value of 2 for a descending sort. As before, this constant declaration could have been taken from the "METACONS.BAS" file in your MetaCube directory.

Lines 25 through 36 establish a multi-dimensional connection to the relational database, as before. As we define the query in the ensuing section, we append lines 48 and 49, in which we assign the value represented by the SortDirectionDesc constant to the SortDirection property of MySortCategory.

Since SortDirectionDesc equals 2, MetaCube will arrange the values of the Region attribute in a descending order, that is, reverse-alphabetically.

MetaCube API Exercise 7: Calculating Absolute Change

In this exercise, we add a calculated measure to the query definition, displaying the difference between every two columns of raw data in an interpolated column. The function for calculating the difference between the two columns is drawn from the main MetaCube snap-in or extension, MCPlgMn, which the MetaCube installation program enables, rendering it available in all application development environments. See "The Extension Class of Objects" on page 5-3 for more details on extensions.

```
Option Explicit 'All variables declared explicitly

Sub MetaCube_API()

'Declare Variables and Constants
    'Object Variables
    Dim MyMetabase As Object, _
        FilterFolder as Object, _
        MyQuery As Object, _
        MyMetaCube As Object
        MySummaryCategory As Object, _
        MySortCategory As Object, _
        MyPivotCategory As Object

    'Excel Variables
    Dim ReportRange As Range

    'Other Variables
    Dim MyData As Variant

    Const OrientationColumn = 2
    Const SortDirectionDesc = 2

    Const MyFirstAttribute = "Brand"
    Const MySecondAttribute = "Region"
    Const MyThirdAttribute = "Fiscal Week"
    Const MyMeasure = "Units Sold"
    Const MySavedFilter = "Boston"

'Instantiate Metabase: Log in to RDBMS, Open DSS System
    'Instantiate a Metabase object
    Set MyMetabase = CreateObject("Metabase")

    'Identify an ODBC data source
    Let MyMetabase.ConnectString = "Metademo"
    'Specify a set of metadata
    Let MyMetabase.Name = "MetaCube Demo"
    'Specify login to database
    Let MyMetabase.Login = "Metademo"
    'Passes value to database on connection
    'Specify database password
    Let MyMetabase.Password = "Metademo"
    'Log in to demonstration database, open DSS System
    MyMetabase.Connect
'Identify folder containing filters
Set FilterFolder = MyMetabase.RootFolder. _
    Folders.Item("Public Filters")
'Define the Query
Set MyQuery = MyMetabase.Queries.Add("A New Query")
'Adds query to MyMetabase's collection of queries
Set MySummaryCategory = _
    MyQuery.QueryCategories.Add(MyFirst Attribute)
Set MySortCategory = MyQuery.QueryCategories.Add _
    (MySecondAttribute)
'Sort attribute values in reverse-alphabetical order
Let MySortCategory.SortDirection = _
    SortDirectionDesc
Set MyPivotCategory = _
    MyQuery.QueryCategories.Add(MyThirdAttribute)
'Pivot this attribute to the column orientation
Let MyPivotCategory.Orientation = OrientationColumn
'Add measure to MyQuery's collection of measures
MyQuery.QueryItems.Add MyMeasure
'Add second measure, on which to perform calculation
MyQuery.QueryItems.Add _
    "Abs_Change (" + MyMeasure + ")"
'Apply filter: specify filter name, who saved, and folder
MyQuery.Filters.AddSaved _
    MySavedFilter, "metapub", FilterFolder
'Display Query Definition
MsgBox MyQuery.SQL
'MetaCube generates SQL for query prior to execution
'Get Query Results, Define Report
'Add cube to MyQuery's cube collection
Set MyMetaCube = MyQuery.MetaCubes.Add("New Cube")
```

```
68 'Format data as an array VB can display, store in variable
69 Let MyData = MyMetaCube.ToVBArray
70 'The ToVBArray method implicitly requires MetaCube
71 'to execute the query on the relational database

72 'Clear "Query Report" Worksheet
73 Sheets("Query Report").Activate
74 Cells.Select
75 Selection.ClearContents

76 'Excel Code: Defines Range of Cells, Presents Data
77 Worksheets.Item("Query Report").Activate
78 Set ReportRange = _
79     ActiveSheet.Range _
80     (ActiveSheet.Cells(1, 1), _
81     ActiveSheet.Cells _
82     (MyMetaCube.Rows, MyMetaCube.Columns))
83 Let ReportRange.Value = MyData
84 ReportRange.EntireColumn.AutoFit 'Sizes columns

85 End Sub
```

Explanation of MetaCube API Exercise 7

MetaCube supports sophisticated comparison calculations, such as percent of total, moving averages and quantiles. In this procedure, MetaCube evaluates the difference in sales from one week to the next. For each column of raw data in our report the difference between that column and the preceding column of raw data is calculated and displayed in an interpolated third column.

The syntax for each calculation varies from function to function, depending on the number of arguments required by that function. Because the function itself returns values that MetaCube incorporates into the result as a QueryItem, we enclose the entire expression in quotation marks, and the arguments required by the function in parentheses, as shown on lines 57 and 58. The plus symbols are required to concatenate the constant name with the rest of the string expression.

The only argument required by the absolute change function is the measure on which the calculation is performed. This function evaluates data as it changes from column to column. Other functions operate on data as it changes from row to row.

Please note that we could have based the calculation on a measure otherwise excluded from the report, displaying the number of Units Sold each week, as well the change in Gross Revenues or Incurred Costs from week to week. Such calculations prompt MetaCube to generate SQL that retrieves from the database the numeric necessary to perform the calculation, while only displaying the result of that calculation.

While most calculations are performed by functions included in MetaCube's main extension, the Summary object performs subtotals and other similar calculations. Subtotals are the subject of MetaCube API Exercise 8.

MetaCube API Exercise 8: Subtotals

In this exercise we deploy the Summary object to calculate subtotals in a report.

```
Option Explicit 'All variables declared explicitly

Sub MetaCube_API()

'Declare Variables and Constants
    'Object Variables
    Dim MyMetabase As Object, _
        FilterFolder as Object, _
        MyQuery As Object, _
        MyMetaCube As Object
        MySummaryCategory As Object, _
        MySortCategory As Object, _
        MyPivotCategory As Object

    'Excel Variables
    Dim ReportRange As Range

    'Other Variables
    Dim MyData As Variant

    Const OrientationColumn = 2
    Const SortDirectionDesc = 2
    Const SummaryTotal = 1
    Const MyFirstAttribute = "Brand"
    Const MySecondAttribute = "Region"
    Const MyThirdAttribute = "Fiscal Week"
    Const MyMeasure = "Units Sold"
    Const MySavedFilter = "Boston"

'Instantiate Metabase: Log in to RDBMS, Open DSS System
    'Instantiate a Metabase object
    Set MyMetabase = CreateObject("Metabase")
```

```
          'Identify an ODBC data source
          Let MyMetabase.ConnectString = "Metademo"

          'Specify a set of metadata
          Let MyMetabase.Name = "MetaCube Demo"

          'Specify login to database
          Let MyMetabase.Login = "Metademo"
          'Passes value to database on connection

          'Specify database password
          Let MyMetabase.Password = "Metademo"

          'Log in to demonstration database, open DSS System
          MyMetabase.Connect

      'Identify folder containing filters
      Set FilterFolder = MyMetabase.RootFolder. _
          Folders.Item("Public Filters")

      'Define the Query
      Set MyQuery = MyMetabase.Queries.Add("A New Query")
      'Adds query to MyMetabase's collection of queries

      Set MySummaryCategory = _
          MyQuery.QueryCategories.Add(MyFirst Attribute)

      Set MySortCategory = MyQuery.QueryCategories.Add _
          (MySecondAttribute)
      'Sort attribute values in reverse-alphabetical order
      Let MySortCategory.SortDirection = _
          SortDirectionDesc

      Set MyPivotCategory = _
          MyQuery.QueryCategories.Add(MyThirdAttribute)
      'Pivot this attribute to the column orientation
      Let MyPivotCategory.Orientation = OrientationColumn

      'Add measure to MyQuery's collection of measures
      MyQuery.QueryItems.Add MyMeasure

      'Add second measure, on which to perform calculation
      MyQuery.QueryItems.Add _
          "Abs_Change (" + MyMeasure + ")"

      'Apply filter: specify filter name, who saved, and folder
      MyQuery.Filters.AddSaved _
          MySavedFilter, "metapub", FilterFolder

      'Display Query Definition
      MsgBox MyQuery.SQL
      'MetaCube generates SQL for query prior to execution
```

```
'Get Query Results, Define Report
'Add cube to MyQuery's cube collection
Set MyMetaCube = MyQuery.MetaCubes.Add("New Cube")

'Subtotal: Regional sales for each brand
MyMetaCube.Summaries.Add  _
    MySummaryCategory, SummaryTotal

'Format data as an array VB can display, store in variable
Let MyData = MyMetaCube.ToVBArray
'The ToVBArray method implicitly requires MetaCube
'to execute the query on the relational database

'Clear "Query Report" Worksheet
Sheets("Query Report").Activate
Cells.Select
Selection.ClearContents

'Excel Code: Defines Range of Cells, Presents Data
Worksheets.Item("Query Report").Activate
Set ReportRange = _
    ActiveSheet.Range _
    (ActiveSheet.Cells(1, 1), _
    ActiveSheet.Cells _
    (MyMetaCube.Rows, MyMetaCube.Columns))
Let ReportRange.Value = MyData
ReportRange.EntireColumn.AutoFit 'Sizes columns

End Sub
```

Explanation of MetaCube API Exercise 8

MetaCube groups information by different attribute values, so you can calculate subtotals for each grouping. In the report generated by our procedure, MetaCube returns a record for each brand's sales in each region, grouping regional brand sales by brand. To calculate a brand's total sales in all regions, we simply sum every region's brands sales for that particular brand. In this case, we perform a subtotal by brand. For each brand, MetaCube interpolates a row representing that brand's total sales for all regions.

The subtotal calculation is performed on an existing set of data by instantiating an object within a collection belonging to the MetaCube object. For subtotals, as well as for averages, minimums, maximums, and counts and grand totals, we instantiate an object of the Summary class, which descends from the MetaCube class of objects.

Both the QueryCategory on which the calculation is performed and the type of calculation to be performed depend on the arguments included in the command instantiating the SummaryObject. On line 18, we declare a constant, SummaryTotal, to store the numeric argument directing the Summary object to calculate subtotals. Other arguments direct the object to calculate averages, counts, minimums and maximums, both for each brand and for the entire report. See Table 8-26 on page 8-70.

Lines 70 and 71 instantiate the Summary object, specifying MyMetaCube's collection of Summary objects, and deploying the general Add method. Two arguments follow, the first identifying the QueryCategory object on which to perform the calculation, the second indicating the type of calculation to perform. Please note that the first argument requires you to specify the actual QueryCategory object, rather than simply identifying the object by name. For this reason, we store all QueryCategory objects in object variables.

We have now completed many of the standard query operations. Exercises appearing in later sections of this manual demonstrate the programming interface for more complex query operations such as buckets, comparisons, multi-fact table queries, background query processing, and parameterized filters. See in particular MetaCube API Exercise 16 on page 5-44, MetaCube API Exercise 17 on page 6-25, and MetaCube API Exercise 21 on page 8-15.

The remainder of the tutorial discusses the construction of a simple query interface for defining ad hoc queries.

MetaCube API Exercise 9: Building an Interface

In this exercise we populate several listboxes with the names of all the attributes available for querying in the DSS System to which we have connected.

```
Option Explicit 'All variables declared explicitly

Sub MetaCube_API()

'Declare Variables and Constants
    'Object Variables
    Dim MyMetabase As Object, _
        FilterFolder as Object, _
        MyQuery As Object, _
        MyMetaCube As Object
        MySummaryCategory As Object, _
        MySortCategory As Object, _
        MyPivotCategory As Object

    'Excel Variables
    Dim ReportRange As Range
        MyListBox As ListBox

    'Other Variables
    Dim MyData As Variant
        ArrayofItems As Variant, _
        DimensionCount As Integer

    Const OrientationColumn = 2
    Const SortDirectionDesc = 2
    Const SummaryTotal = 1
    Const DisplayStyleQuery = 2

    Const MyFirstAttribute = “Brand”
    Const MySecondAttribute = “Region”
    Const MyThirdAttribute = “Fiscal Week”
    Const MyMeasure = “Units Sold”
    Const MySavedFilter = “Boston”

'Instantiate Metabase: Log in to RDBMS, Open DSS System
    'Instantiate a Metabase object
    Set MyMetabase = CreateObject("Metabase")

    'Identify an ODBC data source
    Let MyMetabase.ConnectString = "Metademo"

    'Specify a set of metadata
    Let MyMetabase.Name = "MetaCube Demo"

    'Specify login to database
    Let MyMetabase.Login = "Metademo"
    'Passes value to database on connection
    'Specify database password
    Let MyMetabase.Password = "Metademo"

    'Log in to demonstration database, open DSS System
    MyMetabase.Connect

'Identify folder containing filters
Set FilterFolder = MyMetabase.RootFolder. _
    Folders.Item("Public Filters")

'Query Interface: Attributes
    Worksheets.Item("Define the Query").Activate

'Cycle through DSS System's dimension
For DimensionCount = 0 To _
        MyMetabase.Dimensions, Count - 1

    'Get array of attributes
    Let ArrayofItems = _
        MyMetabase.Dimensions.Item(DimensionCount) . _
        AttributeNames(DisplayStyleQuery).ArrayValues

    'Create listboxes
    Set MyListBox = ActiveSheet.ListBoxes.Add _
        ((DimensionCount * 80), 50, 70, 100)
    'A listbox for each dimension, each further to right

    'Populates each list box w/ attributes of a dimension
    MyListBox.AddItem ArrayofItems

Next DimensionCount

'Define the Query
Set MyQuery = MyMetabase.Queries.Add("A New Query")
'Adds query to MyMetabase's collection of queries

Set MySummaryCategory = _
    MyQuery.QueryCategories.Add(MyFirst Attribute)

Set MySortCategory = MyQuery.QueryCategories.Add _
    (MySecondAttribute)
'Sort attribute values in reverse-alphabetical order
Let MySortCategory.SortDirection = _
    SortDirectionDesc

Set MyPivotCategory = _
    MyQuery.QueryCategories.Add(MyThirdAttribute)
'Pivot this attribute to the column orientation
Let MyPivotCategory.Orientation = OrientationColumn

'Add measure to MyQuery's collection of measures
MyQuery.QueryItems.Add MyMeasure
```

```
'Add second measure, on which to perform calculation
MyQuery.QueryItems.Add _
    "Abs_Change (" + MyMeasure + ")"

'Apply filter: specify filter name, who saved, and folder
MyQuery.Filters.AddSaved _
    MySavedFilter, "metapub", FilterFolder

'Display Query Definition
MsgBox MyQuery.SQL
'MetaCube generates SQL for query prior to execution

'Get Query Results, Define Report
'Add cube to MyQuery's cube collection
Set MyMetaCube = MyQuery.MetaCubes.Add("New Cube")

'Subtotal: Regional sales for each brand
MyMetaCube.Summaries.Add  _
    MySummaryCategory, SummaryTotal

'Format data as an array VB can display, store in variable
Let MyData = MyMetaCube.ToVBArray
'The ToVBArray method implicitly requires MetaCube
'to execute the query on the relational database

'Clear "Query Report" Worksheet
Sheets("Query Report").Activate
Cells.Select
Selection.ClearContents

'Excel Code: Defines Range of Cells, Presents Data
Worksheets.Item("Query Report").Activate
Set ReportRange = _
    ActiveSheet.Range _
    (ActiveSheet.Cells(1, 1), _
    ActiveSheet.Cells _
    (MyMetaCube.Rows, MyMetaCube.Columns))
Let ReportRange.Value = MyData
ReportRange.EntireColumn.AutoFit 'Sizes columns

End Sub
```

Explanation of MetaCube API Exercise 9

This exercise and the two exercises that follow create a simple query interface, displaying lists of available attributes, measures, and saved filters. While we build this interface, our application will continue to execute the query we defined in the previous exercises. Ultimately, however, we can prompt the user to enter the names of attributes, measures, and filters to define the query.

This exercise populates a set of listboxes with the attributes for each dimension in the “MetaCube Demo” DSS System, the first step in building an interface for designing a query. Building even a simple interface requires extensive deployment of Excel-specific objects, properties, and methods. For this reason, you may want to avail yourself of the code provided in the tab labeled “Exercise #9” in the M3_API.xls workbook, installed in the exercises subdirectory of your MetaCube directory. As we are primarily concerned with understanding MetaCube’s programming interface and not Excel, our treatment of this exercise will be somewhat cursory.

Lines 17 and 18 declare two variables, ArrayofItems and DimensionCount. In this exercise, the ArrayofItems variant variable stores an array of attribute names that MetaCube retrieves from the metadata and displays in a listbox for each dimension. The DimensionCount integer serves as a counter in a For... Next loop that cycles through each dimension in the DSS System. This loop does not, however, count through each attribute for each dimension, as the names of the attributes associated with a particular dimension can be retrieved together as an array.

A For... Next loop repeats an action or series of actions a set number of times. In this exercise, the number of repetitions is determined by the number of dimensions in the DSS System, as represented by the Metabase object MyMetabase. MyMetabase owns a collection of dimensions, which has, as a collection, a Count property. Note that this collection was not pictured in the simplified diagram of Figure 1-1 on page 1-9. In line 49, the Count property returns the number of items within the collection; in this case the number of dimensions in MyMetabase’s collection. The metadata for this DSS System, downloaded from the relational database upon connection, populates this collection with a set of Dimension objects. Note that since the Dimension-Count loop counter begins at zero, we must subtract one from the number of dimensions, as their count begins at one. This ensures that the loop repeats only once for each dimension.

For each dimension, the loop performs three tasks:

- retrieves the names of that dimension’s attributes identified as valid for use in queries
- creates a separate listbox, positioning each new listbox progressively further to the right
- populates the listbox with the names of the attributes

Lines 51 through 53 retrieve as an array the attributes for a particular dimension. The latter half of this complicated equation can best be understood in parts.

The first part of the equation, MyMetabase.Dimensions.Item (DimensionsCount), specifies the dimension for which MetaCube will retrieve an array of attributes. The MyMetabase instantiation of the Metabase class of objects represents a particular multi-dimensional view of relational data, as defined by the “MetaCube Demo” DSS System.

Like any Metabase object, MyMetabase owns a collection of Dimensions and Fact Tables, the fundamental logical objects in any DSS System. Because a DSS System can associate different dimensions with different Fact Tables, each Fact Table also has a collection of Dimensions, a subset of the Metabase object’s collection that specifically correspond to the parent fact table.

The fact table at issue in the demonstration system, however, joins to all dimensions, so the DSS System’s collection of Dimension objects contains the same items as the FactTable object’s collection. We can thus safely refer to MyMetabase’s collection of Dimensions without including a Dimension object associated with the wrong fact table.

On line 52, we identify the collection of Dimensions owned by the Metabase object in the usual way, specifying first the parent and then the collection itself. The Dimension object within the collection is identified by index number.

Rather than providing a constant value for the index number, we can identify different dimensions by incrementing the index number at every cycle through the For... Next loop. With each iteration of the loop, the DimensionCount integer increments by one, identifying a different item within MyMetabase’s collection of dimensions.

The second part of the equation, AttributeNames(DisplayStyleQuery).ArrayValues, retrieves all valid attributes within the specified dimension, returning those values as an array. The DisplayStyleQuery argument, which corresponds to a numeric constant declared on line 22, specifies attributes that have been validated for use in queries. A different argument value specifies only those attributes validated for use in filters. When you create the metadata for an attribute, you indicate whether the attribute is valid for use in queries or filters or both. For an explanation of how to validate attributes for use in queries or filters through MetaCube’s programming interface, see Table 4-7 on page 4-15.

Please note that MetaCube initially returns the attribute name in a generic format, which the ArrayValues method converts to an array. For development environments that do not support arrays, such as Visual Basic 3.0, MetaCube can return value sets in different formats, such as tab-delimited strings. The ArrayofItems variable automatically sizes itself to store the values of the array.

Lines 55 and 56 create a listbox in the active worksheet, “Define the Query.” This instance of the listbox is stored in the MyListBox variable, which we declared in line 14 as a special Excel-type variable. Including the DimensionCount variable as a parameter for positioning the listbox moves the location of each new listbox further to the right as the loop counter increments. Line 59 displays the list of attribute names in the most recently created listbox. For more information about creating, positioning, and populating listboxes, consult Excel’s on-line Visual Basic for Applications Help.

The remainder of this procedure defines and executes the query as before.

MetaCube API Exercise 10: Creating and Populating a Measures ListBox

In this exercise we populate a listbox with the names of the measures available in the DSS System to which we have connected.

```
1   Option Explicit 'All variables declared explicitly
2   Sub MetaCube_API()
3   'Declare Variables and Constants
4       'Object Variables
5       Dim MyMetabase As Object, _
6           FilterFolder as Object, _
7           MyQuery As Object, _
8           MyMetaCube As Object
9           MySummaryCategory As Object, _
10          MySortCategory As Object, _
11          MyPivotCategory As Object
12      'Excel Variables
13      Dim ReportRange As Range
14          MyListBox As ListBox
15      'Other Variables
16      Dim MyData As Variant
17          ArrayofItems As Variant, _
18          DimensionCount As Integer
```

```
    Const OrientationColumn = 2
    Const SortDirectionDesc = 2
    Const SummaryTotal = 1
    Const DisplayStyleQuery = 2
    Const MyFirstAttribute = “Brand”
    Const MySecondAttribute = “Region”
    Const MyThirdAttribute = “Fiscal Week”
    Const MyMeasure = “Units Sold”
    Const MySavedFilter = “Boston”
'Instantiate Metabase: Log in to RDBMS, Open DSS System
    'Instantiate a Metabase object
    Set MyMetabase = CreateObject("Metabase")
    'Identify an ODBC data source
    Let MyMetabase.ConnectString = "Metademo"
    'Specify a set of metadata
    Let MyMetabase.Name = "MetaCube Demo"
    'Specify login to database
    Let MyMetabase.Login = "Metademo"
    'Passes value to database on connection
    'Specify database password
    Let MyMetabase.Password = "Metademo"
    'Log in to demonstration database, open DSS System
    MyMetabase.Connect
'Identify folder containing filters
Set FilterFolder = MyMetabase.RootFolder. _
    Folders.Item(“Public Filters”)
'Query Interface: Attributes
    Worksheets.Item(“Define the Query”).Activate
'Cycle through DSS System’s dimension
For DimensionCount = 0 To _
        MyMetabase.Dimensions, Count - 1
    'Get array of attributes
    Let ArrayofItems = _
        MyMetabase.Dimensions.Item(DimensionCount) . _
        AttributeNames(DisplayStyleQuery) .ArrayValues
    'Create listboxes
    Set MyListBox = ActiveSheet.ListBoxes.Add _
    ((DimensionCount * 80), 50, 70, 100)
    'A listbox for each dimension, each further to right
    'Populates each list box w/ attributes of a dimension
    MyListBox.AddItem ArrayofItems
Next DimensionCount
'Query Interface:  Measures
'Create one list box for measures
Set MyListBox = ActiveSheet.ListBoxes.Add _
    ((DimensionCount * 80), 50, 70, 100)
'Last “Next DimensionCount” added 1, moves listbox right
'Get array of available measure names
Let ArrayofItems = _
    MyMetabase.FactTables. _
    Item("Sales Transactions"). _
    MeasureNames(DisplayStyleQuery).ArrayValues
'Populate listbox with array of measure names
MyListBox.AddItem ArrayofItems
'Define the Query
Set MyQuery = MyMetabase.Queries.Add("A New Query")
'Adds query to MyMetabase’s collection of queries
Set MySummaryCategory = _
    MyQuery.QueryCategories.Add(MyFirst Attribute)
Set MySortCategory = MyQuery.QueryCategories.Add _
    (MySecondAttribute)
'Sort attribute values in reverse-alphabetical order
Let MySortCategory.SortDirection = SortDirectionDesc
Set MyPivotCategory = _
    MyQuery.QueryCategories.Add(MyThirdAttribute)
'Pivot this attribute to the column orientation
Let MyPivotCategory.Orientation = OrientationColumn
'Add measure to MyQuery’s collection of measures
MyQuery.QueryItems.Add MyMeasure
'Add second measure, on which to perform calculation
MyQuery.QueryItems.Add _
    “Abs_Change (“ + MyMeasure + “)”
'Apply filter: specify filter name, who saved, and folder
MyQuery.Filters.AddSaved _
    MySavedFilter, “metapub”, FilterFolder
'Display Query Definition
MsgBox MyQuery.SQL
'MetaCube generates SQL for query prior to execution
'Get Query Results, Define Report
'Add cube to MyQuery’s cube collection
Set MyMetaCube = MyQuery.MetaCubes.Add("New Cube")
```

```
100 'Subtotal: Regional sales for each brand
101 MyMetaCube.Summaries.Add  _
102     MySummaryCategory, SummaryTotal

103 'Format data as an array VB can display, store in variable
104 Let MyData = MyMetaCube.ToVBArray
105 'The ToVBArray method implicitly requires MetaCube
106 'to execute the query on the relational database

107 'Clear "Query Report" Worksheet
108 Sheets("Query Report").Activate
109 Cells.Select
110 Selection.ClearContents

111 'Excel Code: Defines Range of Cells, Presents Data
112 Worksheets.Item("Query Report").Activate
113 Set ReportRange = _
114     ActiveSheet.Range _
115     (ActiveSheet.Cells(1, 1), _
116     ActiveSheet.Cells _
117     (MyMetaCube.Rows, MyMetaCube.Columns))
118 Let ReportRange.Value = MyData
119 ReportRange.EntireColumn.AutoFit 'Sizes columns

120 End Sub
```

Explanation of MetaCube API Exercise 10

This exercise creates a listbox to store the names of measures available in our data source, the “Sales Transactions” fact table. As before, the new code for this exercise relies heavily upon Excel functionality and can be copied from the tab labeled “Exercise #10” in the M3_API.xls workbook, located in your MetaCube training directory.

The syntax for populating a listbox with measures is nearly identical to the code in lines 48 through 60, which displays the attributes for each dimension in separate listboxes. Consequently, we can re-use the variables and constants declared in the previous exercise. For this and other reasons, our task in this exercise is simpler than before.

In the previous exercise we cycled through every dimension in the DSS System to retrieve the names of valid query attributes, but to retrieve the names of measures we need merely access a single fact table's collection of measures. Although you can define a query retrieving information from multiple fact tables, such a task is slightly more complicated and is left to advanced developers. This exercise creates a listbox to display the valid query measures for one of the two fact tables in the "MetaCube Demo" DSS System, the "Sales Transaction" fact table.

Lines 63 and 64 create this listbox, including the DimensionCount variable as an element in the set of arguments that determine its location. As the value of the DimensionCount variable increases, the position of the listbox moves further to the right. Because the last line of the loop defined in the previous exercise increments the DimensionsCount loop counter before exiting the loop, the position of the left edge of the new measures listbox appears 80 points to the right of the last dimension listbox. Each point corresponds to 1/72nd of an inch.

Lines 67 through 70 store an array of measure names in the ArrayofItems variant variable. This complicated command parallels the structure of the command to retrieve a dimension's array of attribute names (lines 51 through 53). The command begins by identifying the particular fact table within a DSS System for which you want to retrieve measure names. We do not reference this collection item by a variable index number, as we did when identifying dimensions, but by name.

All of the exercises in this tutorial have, by default, queried on measures in the fact table that we now explicitly identify as "Sales Transactions." This fact table is the default by virtue of having been instantiated first when the metadata for this DSS System was created.

The MeasureNames property represents the names of all valid measures stored in a particular fact table. This property requires the same argument as the AttributeNames property, in which the DisplayStyleQuery constant limits the items in the array to those validated for use in a query. As before, the ArrayValues method returns the set of measure names as an array, which the variant variable, ArrayofItems can easily accept. Line 72 populates the newly-created listbox with this array of measure names.

MetaCube API Exercise 11: Displaying a List of Saved Filters

In this exercise, we complete the interface begun in Exercise #9, displaying the names of all filters saved by the metapub user in a particular folder object.

```
Option Explicit 'All variables declared explicitly

Sub MetaCube_API()

'Declare Variables and Constants
    'Object Variables
    Dim MyMetabase As Object, _
        FilterFolder as Object, _
        MyQuery As Object, _
        MyMetaCube As Object
        MySummaryCategory As Object, _
        MySortCategory As Object, _
        MyPivotCategory As Object

    'Excel Variables
    Dim ReportRange As Range
        MyListBox As ListBox

    'Other Variables
    Dim MyData As Variant
        ArrayofItems As Variant, _
        DimensionCount As Integer

    Const OrientationColumn = 2
    Const SortDirectionDesc = 2
    Const SummaryTotal = 1
    Const DisplayStyleQuery = 2

    Const MyFirstAttribute = “Brand”
    Const MySecondAttribute = “Region”
    Const MyThirdAttribute = “Fiscal Week”
    Const MyMeasure = “Units Sold”
    Const MySavedFilter = “Boston”

'Instantiate Metabase: Log in to RDBMS, Open DSS System
    'Instantiate a Metabase object
    Set MyMetabase = CreateObject("Metabase")

    'Identify an ODBC data source
    Let MyMetabase.ConnectString = "Metademo"

    'Specify a set of metadata
    Let MyMetabase.Name = "MetaCube Demo"

    'Specify login to database
    Let MyMetabase.Login = "Metademo"
    'Passes value to database on connection
    'Specify database password
    Let MyMetabase.Password = "Metademo"
    'Log in to demonstration database, open DSS System
    MyMetabase.Connect
'Identify folder containing filters
Set FilterFolder = MyMetabase.RootFolder. _
    Folders.Item(“Public Filters”)
'Query Interface: Attributes
    Worksheets.Item(“Define the Query”).Activate
'Cycle through DSS System’s dimension
For DimensionCount = 0 To _
        MyMetabase.Dimensions, Count - 1
    'Get array of attributes
    Let ArrayofItems = _
        MyMetabase.Dimensions.Item(DimensionCount) . _
        AttributeNames(DisplayStyleQuery) .ArrayValues
    'Create listboxes
    Set MyListBox = ActiveSheet.ListBoxes.Add _
    ((DimensionCount * 80), 50, 70, 100)
    'A listbox for each dimension, each further to right
    'Populates each list box w/ attributes of a dimension
    MyListBox.AddItem ArrayofItems
Next DimensionCount
'Query Interface:  Measures
'Create one list box for measures
Set MyListBox = ActiveSheet.ListBoxes.Add _
    ((DimensionCount * 80), 50, 70, 100)
'Last “Next DimensionCount” added 1, moves listbox right
'Get array of available measure names
Let ArrayofItems = _
    MyMetabase.FactTables. _
    Item("Sales Transactions"). _
    MeasureNames(DisplayStyleQuery).ArrayValues
'Populate listbox with array of measure names
MyListBox.AddItem ArrayofItems
'Query Interface:  Saved Filters
'Create listbox for saved filters
Set MyListBox = ActiveSheet.ListBoxes.Add _
    (((DimensionCount + 1) * 80), 50, 120, 150)
'Increments "DimensionCount" by 1, moves listbox to right
```

```
'Get array of filters in root folder owned by metapub
Let ArrayofItems = _
    FilterFolder.FilterNames _
    ("metapub", "").ArrayValues
'Populate list box with array of filter names
MyListBox.AddItem ArrayofItems
'Define the Query
Set MyQuery = MyMetabase.Queries.Add("A New Query")
'Adds query to MyMetabase’s collection of queries
Set MySummaryCategory = _
    MyQuery.QueryCategories.Add(MyFirst Attribute)
Set MySortCategory = MyQuery.QueryCategories.Add _
    (MySecondAttribute)
'Sort attribute values in reverse-alphabetical order
Let MySortCategory.SortDirection = SortDirectionDesc
Set MyPivotCategory = _
    MyQuery.QueryCategories.Add(MyThirdAttribute)
'Pivot this attribute to the column orientation
Let MyPivotCategory.Orientation = OrientationColumn
'Add measure to MyQuery’s collection of measures
MyQuery.QueryItems.Add MyMeasure
'Add second measure, on which to perform calculation
MyQuery.QueryItems.Add _
    “Abs_Change (“ + MyMeasure + “)”
'Apply filter: specify filter name, who saved, and folder
MyQuery.Filters.AddSaved _
    MySavedFilter, “metapub”, FilterFolder
'Display Query Definition
MsgBox MyQuery.SQL
'MetaCube generates SQL for query prior to execution
'Get Query Results, Define Report
'Add cube to MyQuery’s cube collection
Set MyMetaCube = MyQuery.MetaCubes.Add("New Cube")
'Subtotal: Regional sales for each brand
MyMetaCube.Summaries.Add  _
    MySummaryCategory, SummaryTotal
'Format data as an array VB can display, store in variable
Let MyData = MyMetaCube.ToVBArray
'The ToVBArray method implicitly requires MetaCube
'to execute the query on the relational database
```

```
118 'Clear "Query Report" Worksheet
119 Sheets("Query Report").Activate
120 Cells.Select
121 Selection.ClearContents
122 'Excel Code: Defines Range of Cells, Presents Data
123 Worksheets.Item("Query Report").Activate
124 Set ReportRange = _
125     ActiveSheet.Range _
126     (ActiveSheet.Cells(1, 1), _
127     ActiveSheet.Cells _
128     (MyMetaCube.Rows, MyMetaCube.Columns))
129 Let ReportRange.Value = MyData
130 ReportRange.EntireColumn.AutoFit 'Sizes columns
131 End Sub
```

Explanation of MetaCube API Exercise 11

In this exercise, we display the names of publicly-saved filters, completing our simple query interface. As before, we can incorporate variables declared for previous sections of the application, such as MyListBox, ArrayofItems, and DimensionCount. The new listbox object, instantiated and stored in MyListBox on lines 75 and 76, is positioned to the right of previous listboxes. The DimensionCount variable, used throughout the application as a parameter for the horizontal positioning of listboxes, is artificially incremented by one from its previous value and multiplied by a factor of 80. It remains for us to retrieve the names of the filters stored in the root folder for this DSS System.

As we discussed previously in "Explanation of MetaCube API Exercise 4" on page 2-16, MetaCube offers a hierarchical folder interface for storing logical objects as metadata. The RootFolder object owned by the Metabase object represents the first folder, and any Folder objects owned by RootFolder represent subdirectories of that first folder.

On lines 79 through 81 of this exercise, we display in a listbox the names of filters saved by MetaCube's public user, metapub, in the folder identified by the FilterFolder object. The FilterNames method of any Folder object, including the RootFolder object, requires two arguments: the name of the user who saved the filters in question, and the name of the group to which those filters belong. Usually filters are organized by group according to the dimension with which they are associated. Passing an empty string for the second argument returns all filters, regardless of their groupings. Since the FilterNames method returns the names of all filters in a generic format, the ArrayValues method converts the value list to an array that is ultimately stored in the ArrayofItems variant variable.

Line 83 adds the items in this array to the listbox defined in lines 75 and 76. The remainder of the procedure executes as before.

MetaCube API Exercise 12: Prompting Users to Define Queries

In this exercise we replace the constants previously supplying the arguments for attribute, measure, and filter specifications with variables, the values of which can be supplied by a user.

```
1  Option Explicit 'All variables declared explicitly
2  Sub MetaCube_API()
3  'Declare Variables and Constants
4      'Object Variables
5      Dim MyMetabase As Object, _
6          FilterFolder as Object, _
7          MyQuery As Object, _
8          MyMetaCube As Object
9          MySummaryCategory As Object, _
10         MySortCategory As Object, _
11         MyPivotCategory As Object
12     'Excel Variables
13     Dim ReportRange As Range
14         MyListBox As ListBox
```

```
    'Other Variables
    Dim MyData As Variant
        ArrayofItems As Variant, _
        DimensionCount As Integer
        MyFirstAttribute As String, _
        MySecondAttribute As String, _
        MyThirdAttribute As String, _
        MyMeasure As String, _
        MySavedFilter As String

    Const OrientationColumn = 2
    Const SortDirectionDesc = 2
    Const SummaryTotal = 1
    Const DisplayStyleQuery = 2
    ~~Const MyFirstAttribute = “Brand”~~
    ~~Const MySecondAttribute = “Region”~~
    ~~Const MyThirdAttribute = “Fiscal Week”~~
    ~~Const MyMeasure = “Units Sold”~~
    ~~Const MySavedFilter = “Boston”~~

'Instantiate Metabase: Log in to RDBMS, Open DSS System
    'Instantiate a Metabase object
    Set MyMetabase = CreateObject("Metabase")

    'Identify an ODBC data source
    Let MyMetabase.ConnectString = "Metademo"

    'Specify a set of metadata
    Let MyMetabase.Name = "MetaCube Demo"

    'Specify login to database
    Let MyMetabase.Login = "Metademo"
    'Passes value to database on connection

    'Specify database password
    Let MyMetabase.Password = "Metademo"

    'Log in to demonstration database, open DSS System
    MyMetabase.Connect

'Identify folder containing filters
Set FilterFolder = MyMetabase.RootFolder. _
    Folders.Item(“Public Filters”)

'Query Interface: Attributes
    Worksheets.Item(“Define the Query”).Activate

'Cycle through DSS System’s dimension
For DimensionCount = 0 To _
        MyMetabase.Dimensions, Count - 1
    'Get array of attributes
    Let ArrayofItems = _
        MyMetabase.Dimensions.Item(DimensionCount) . _
        AttributeNames(DisplayStyleQuery) .ArrayValues
    'Create listboxes
    Set MyListBox = ActiveSheet.ListBoxes.Add _
    ((DimensionCount * 80), 50, 70, 100)
    'A listbox for each dimension, each further to right
    'Populates each list box w/ attributes of a dimension
    MyListBox.AddItem ArrayofItems
Next DimensionCount
'Query Interface:  Measures
'Create one list box for measures
Set MyListBox = ActiveSheet.ListBoxes.Add _
    ((DimensionCount * 80), 50, 70, 100)
'Last "Next DimensionCount" added 1, moves listbox right
'Get array of available measure names
Let ArrayofItems = _
    MyMetabase.FactTables. _
    Item("Sales Transactions"). _
    MeasureNames(DisplayStyleQuery).ArrayValues
'Populate listbox with array of measure names
MyListBox.AddItem ArrayofItems
'Query Interface:  Saved Filters
'Create listbox for saved filters
Set MyListBox = ActiveSheet.ListBoxes.Add _
    (((DimensionCount + 1) * 80), 50, 120, 150)
'Increments "DimensionCount" by 1, moves listbox to right
'Get array of filters in root folder owned by metapub
Let ArrayofItems = _
    FilterFolder.FilterNames _
    ("metapub", "").ArrayValues
'Populate list box with array of filter names
MyListBox.AddItem ArrayofItems
'Retrieve Names of Attributes, Measure, Filter from User
Let MyFirstAttribute = _
        InputBox(Prompt:= _
        "Enter an attribute on which to query:", _
        Title:="First Attribute")
```

```
Let MySecondAttribute = _
        InputBox(Prompt:= _
        "Enter the name of another attribute:", _
        Title:="Second Attribute")
Let MyThirdAttribute = _
        InputBox(Prompt:= _
        "Enter the name of a third attribute:", _
        Title:="Attribute Organized by Columns")
Let MyMeasure = _
        InputBox(Prompt:= _
        "Enter a measure on which to query:", _
        Title:="Measure")
Let MySavedFilter = _
        InputBox(Prompt:= _
        "Enter the name of a saved filter:", _
        Title:="Filter")
'Define the Query
Set MyQuery = MyMetabase.Queries.Add("A New Query")
'Adds query to MyMetabase's collection of queries
Set MySummaryCategory = _
    MyQuery.QueryCategories.Add(MyFirst Attribute)
Set MySortCategory = MyQuery.QueryCategories.Add _
    (MySecondAttribute)
'Sort attribute values in reverse-alphabetical order
Let MySortCategory.SortDirection = SortDirectionDesc
Set MyPivotCategory = _
    MyQuery.QueryCategories.Add(MyThirdAttribute)
'Pivot this attribute to the column orientation
Let MyPivotCategory.Orientation = OrientationColumn
'Add measure to MyQuery's collection of measures
MyQuery.QueryItems.Add MyMeasure
'Add second measure, on which to perform calculation
MyQuery.QueryItems.Add _
    “Abs_Change (“ + MyMeasure + “)”
'Apply filter: specify filter name, who saved, and folder
MyQuery.Filters.AddSaved _
    MySavedFilter, “metapub”, FilterFolder
'Display Query Definition
MsgBox MyQuery.SQL
'MetaCube generates SQL for query prior to execution
```

```
'Get Query Results, Define Report
'Add cube to MyQuery's cube collection
Set MyMetaCube = MyQuery.MetaCubes.Add("New Cube")

'Subtotal: Regional sales for each brand
MyMetaCube.Summaries.Add  _
    MySummaryCategory, SummaryTotal

'Format data as an array VB can display, store in variable
Let MyData = MyMetaCube.ToVBArray
'The ToVBArray method implicitly requires MetaCube
'to execute the query on the relational database

'Clear "Query Report" Worksheet
Sheets("Query Report").Activate
Cells.Select
Selection.ClearContents

'Excel Code: Defines Range of Cells, Presents Data
Worksheets.Item("Query Report").Activate
Set ReportRange = _
    ActiveSheet.Range _
    (ActiveSheet.Cells(1, 1), _
    ActiveSheet.Cells _
    (MyMetaCube.Rows, MyMetaCube.Columns))
Let ReportRange.Value = MyData
ReportRange.EntireColumn.AutoFit 'Sizes columns

End Sub
```

Explanation of MetaCube API Exercise 12

This exercise demonstrates how easily you can prompt users to define an ad-hoc query. Because we have declared constants for each parameter in the query definition, we can simply replace those constants with string variables, requesting the user to enter the values for each. The existing structure of Metabase, Query, QueryCategory, QueryItem, MetaCube, and Summary objects remains intact; only the values of their arguments change, as well as the way in which the application provides those values. Consequently, this exercise does not introduce any MetaCube functionality, and all of the new code can be copied from the tab labeled “Exercise #12,” in the M3_API.xls workbook located in your training directory.

Lines 19 through 23 declare variables of the same names as the redacted constants appearing on lines 28 through 32. As the redaction suggests, these variables replace the constants of the same name; you should thus delete these constant declarations. The arguments represented by each variable are all of the string type. As in previous exercises, the procedure subsequently connects to the database and opens a particular multi-dimensional view of the tables and columns, displaying in listboxes the library of attributes, measures, and saved filters that a user can incorporate into his or her query definition.

Lines 90 to 109 prompt the user to provide the names of the three attributes, the measure, and the saved filter included in the query defined on lines 111 through 130. InputBoxes, a standard Visual Basic for Applications object for requesting information from a user, store users' responses in the variables we declared earlier in the procedure. When prompted for the information, the user must precisely identify the attribute, measure, and filter values, as they appear in the listboxes in the "Define the Query" spreadsheet.

Lines 132 through 157 execute the query as before, substituting values provided by the user as arguments in the commands defining the query and the ensuing report.

MetaCube API Exercise 13: Slow Query Warning

In this exercise we include a section evaluating the performance cost of a user-defined query, warning the user if the query accesses large tables.

```
Option Explicit 'All variables declared explicitly

Sub MetaCube_API()

'Declare Variables and Constants
    'Object Variables
    Dim MyMetabase As Object, _
        FilterFolder as Object, _
        MyQuery As Object, _
        MyMetaCube As Object
        MySummaryCategory As Object, _
        MySortCategory As Object, _
        MyPivotCategory As Object

    'Excel Variables
    Dim ReportRange As Range
        MyListBox As ListBox

    'Other Variables
    Dim MyData As Variant
        ArrayofItems As Variant, _
        DimensionCount As Integer
        MyFirstAttribute As String, _
        MySecondAttribute As String, _
        MyThirdAttribute As String, _
        MyMeasure As String, _
        MySavedFilter As String
        CostWarning As Integer

    Const OrientationColumn = 2
    Const SortDirectionDesc = 2
    Const SummaryTotal = 1
    Const DisplayStyleQuery = 2

'Instantiate Metabase: Log in to RDBMS, Open DSS System
    'Instantiate a Metabase object
    Set MyMetabase = CreateObject("Metabase")

    'Identify an ODBC data source
    Let MyMetabase.ConnectString = "Metademo"

    'Specify a set of metadata
    Let MyMetabase.Name = "MetaCube Demo"

    'Specify login to database
    Let MyMetabase.Login = "Metademo"
    'Passes value to database on connection
    'Specify database password
    Let MyMetabase.Password = "Metademo"
    'Log in to demonstration database, open DSS System
    MyMetabase.Connect
'Identify folder containing filters
Set FilterFolder = MyMetabase.RootFolder. _
    Folders.Item("Public Filters")
'Query Interface: Attributes
    Worksheets.Item("Define the Query").Activate
'Cycle through DSS System's dimension
For DimensionCount = 0 To _
        MyMetabase.Dimensions, Count - 1
    'Get array of attributes
    Let ArrayofItems = _
        MyMetabase.Dimensions.Item(DimensionCount) . _
        AttributeNames(DisplayStyleQuery) .ArrayValues
    'Create listboxes
    Set MyListBox = ActiveSheet.ListBoxes.Add _
    ((DimensionCount * 80), 50, 70, 100)
    'A listbox for each dimension, each further to right
    'Populates each list box w/ attributes of a dimension
    MyListBox.AddItem ArrayofItems
Next DimensionCount
'Query Interface:  Measures
'Create one list box for measures
Set MyListBox = ActiveSheet.ListBoxes.Add _
    ((DimensionCount * 80), 50, 70, 100)
'Last "Next DimensionCount" added 1, moves listbox right
'Get array of available measure names
Let ArrayofItems = _
    MyMetabase.FactTables. _
    Item("Sales Transactions"). _
    MeasureNames(DisplayStyleQuery).ArrayValues
'Populate listbox with array of measure names
MyListBox.AddItem ArrayofItems
'Query Interface:  Saved Filters
'Create listbox for saved filters
Set MyListBox = ActiveSheet.ListBoxes.Add _
    (((DimensionCount + 1) * 80), 50, 120, 150)
'Increments "DimensionCount" by 1, moves listbox to right
```

```
'Get array of filters in root folder owned by metapub
Let ArrayofItems = _
    FilterFolder.FilterNames _
    ("metapub", "").ArrayValues

'Populate list box with array of filter names
MyListBox.AddItem ArrayofItems

'Retrieve Names of Attributes, Measure, Filter from User
DefineQuery:
Let MyFirstAttribute = _
        InputBox(Prompt:= _
        "Enter an attribute on which to query:", _
        Title:="First Attribute")

Let MySecondAttribute = _
        InputBox(Prompt:= _
        "Enter the name of another attribute:", _
        Title:="Second Attribute")

Let MyThirdAttribute = _
        InputBox(Prompt:= _
        "Enter the name of a third attribute:", _
        Title:="Attribute Organized by Columns")

Let MyMeasure = _
        InputBox(Prompt:= _
        "Enter a measure on which to query:", _
        Title:="Measure")

Let MySavedFilter = _
        InputBox(Prompt:= _
        "Enter the name of a saved filter:", _
        Title:="Filter")

'Define the Query
Set MyQuery = MyMetabase.Queries.Add("A New Query")
'Adds query to MyMetabase's collection of queries

Set MySummaryCategory = _
    MyQuery.QueryCategories.Add(MyFirst Attribute)

Set MySortCategory = MyQuery.QueryCategories.Add _
    (MySecondAttribute)
'Sort attribute values in reverse-alphabetical order
Let MySortCategory.SortDirection = SortDirectionDesc

Set MyPivotCategory = _
    MyQuery.QueryCategories.Add(MyThirdAttribute)
'Pivot this attribute to the column orientation
Let MyPivotCategory.Orientation = OrientationColumn

'Add measure to MyQuery's collection of measures
MyQuery.QueryItems.Add MyMeasure
```

```
'Add second measure, on which to perform calculation
MyQuery.QueryItems.Add _
    “Abs_Change (“ + MyMeasure + “)”
'Apply filter: specify filter name, who saved, and folder
MyQuery.Filters.AddSaved _
    MySavedFilter, “metapub”, FilterFolder
'Display Query Definition
MsgBox MyQuery.SQL
'MetaCube generates SQL for query prior to execution
'Check cost of tables to be accessed by MetaCube, warn user
If MyQuery.Cost > 30000 Then    'Arbitrary value
        CostWarning = MsgBox _
        (Prompt:= _
    "This query may be slow.  Run query anyway?", _
        Title:="Query Cost Warning", _
        Buttons:= _
        vbYesNo + vbExclamation + vbDefaultButton2)
        'Warn user
    If CostWarning = vbNo Then
        GoTo DefineQuery: 'Allow user to redefine query
    End If                'Otherwise, execute query
End If
'Get Query Results, Define Report
'Add cube to MyQuery’s cube collection
Set MyMetaCube = MyQuery.MetaCubes.Add("New Cube")
'Subtotal: Regional sales for each brand
MyMetaCube.Summaries.Add  _
    MySummaryCategory, SummaryTotal
'Format data as an array VB can display, store in variable
Let MyData = MyMetaCube.ToVBArray
'The ToVBArray method implicitly requires MetaCube
'to execute the query on the relational database
'Clear "Query Report" Worksheet
Sheets("Query Report").Activate
Cells.Select
Selection.ClearContents
```

```
158 'Excel Code: Defines Range of Cells, Presents Data
159 Worksheets.Item("Query Report").Activate
160 Set ReportRange = _
161     ActiveSheet.Range _
162     (ActiveSheet.Cells(1, 1), _
163     ActiveSheet.Cells _
164     (MyMetaCube.Rows, MyMetaCube.Columns))
165 Let ReportRange.Value = MyData
166 ReportRange.EntireColumn.AutoFit 'Sizes columns
167 End Sub
```

Explanation of MetaCube API Exercise 13

Allowing a user to define a query introduces the risk of poorly-designed queries that access extremely large tables. When optimizing the SQL for a particular query, MetaCube assesses the relative performance costs of accessing different tables. These costs, which typically correspond to the number of rows in each table, are assigned by the administrator, who generates a metadata description for each fact or summary table.

When generating the SQL for a query, MetaCube identifies the table that features the lowest possible cost and involves a minimal number of joins. The cost of the fact or summary table for which MetaCube generates SQL represents the cost of the query itself, regardless of the number of rows that the query selects from that table.

Each fully-defined Query object has a Cost property, the value of which is calculated by the MetaCube engine when it generates SQL for that query. On the basis of this value's magnitude, this exercise can warn the user of a possible delay before the query executes, offering him or her the option of redefining the query.

Line 132 evaluates the cost of the query represented by the MyQuery object, setting a threshold of 30,000, which, if exceeded, prompts MetaCube to warn the user. If the query's cost does not exceed this value, the application's execution path ignores the rest of this section of code. In the event a warning is warranted, the application displays the warning in a MsgBox, as specified in lines 133 through 138.

Unlike the MsgBox created in line 129 to show the SQL generated for a query, this MsgBox returns a user-defined value to the CostWarning integer. This value depends on the button clicked by the user, with each button corresponding to a numeric argument. If the user clicks the "No" button, indicating that he or she does not wish to execute the query as currently defined, the nested condition in line 140 is satisfied and line 141 executes. This line returns the user to the section beginning on line 86, identified in this exercise by the header "DefineQuery." By returning to this section, the application forces the user to re-define the query. If the user clicks the "Yes" button, the query runs anyway, ignoring the nested code.

Chapter

The Metabase Class of Objects

3

This chapter introduces the Metabase class of objects, which represent a virtual multi-dimensional database.

The Metabase Class of Objects

Before you can build a query, you must define a logical representation of a multi-dimensional database by creating an instance of the Metabase class of objects. Each Metabase object is the logical representation of a different multi-dimensional database, and the properties of a particular Metabase object specify the characteristics of that multi-dimensional database, including the relational database on which your multi-dimensional system is based, the multi-dimensional interface through which it will be accessed, as well as the analytical functions available.

For every MetaCube procedure, a Metabase object is the founding or “master” object, with all other objects existing as children, grandchildren, great-grandchildren, etc. of this master object.

As a class, Metabase objects stand at the top of a hierarchy of MetaCube object classes. A Metabase object is the parent of a *collection* of queries accessing data from the tables represented by that Metabase object. Objects of the same class are organized into a collection belonging to the parent object. A Metabase’s collection of Query objects represents the different ways in which that instance of a multi-dimensional database can be queried. A query cannot exist but within a collection belonging to the Metabase object; in fact, a free-standing query would be meaningless since a query is defined in terms of the multi-dimensional view of the database (i.e., instance of a Metabase object) that it queries.

All but the most low-level objects are parents of one or more collections. For example, each query is the parent of a collection of selected attributes (Query-Categories), measures (QueryItems), filters (Filters), and reports (MetaCubes). In turn, attributes, measures, filters, and reports define different aspects of a query. More generally, each collection defines an aspect of the parent object.

At the outset of any MetaCube procedure, you must create an instance of the Metabase class. In Visual Basic and Visual Basic for Applications, the CreateObject function performs this task. The class of the object you wish to create is an argument in the CreateObject statement. Before instantiating a Metabase object, you must declare an object variable and set that variable equal to the newly-created instance of the Metabase class of objects:

```
Dim MyMetabase as Object
Set MyMetabase = CreateObject("Metabase")
```

The environment in which you develop MetaCube applications recognizes the Metabase class of objects because MetaCube registers its library of objects when you install MetaCube. While the object variable representing a particular instance of a Metabase class of objects can have any unique name, the Metabase class name that you pass to the CreateObject function is always the same.

Please note that other object classes are not instantiated by a CreateObject function or that function’s analog in other development environments. Instances of object classes other than the Metabase class exist within collections directly or ultimately belonging to an instance of a Metabase object. To instantiate a Query object for example, you need only add a query to a Metabase object’s collection of queries:

```
MyMetabase.Queries.Add “New Brand/Region Query”
```

or

```
Dim MyQuery as Object
Set MyQuery = MyMetabase.Queries.Add _
    (“New Brand/Region Query”)
```

Metabase Properties

Many of the properties of the Metabase object correspond to the preferences of Explorer or Warehouse Manager. These properties specify the characteristics of the virtual multi-dimensional database that the Metabase object represents. Table 3-1 summarizes the properties of the Metabase class of objects.

Connection Information in MetaCube 4.0

MetaCube 4.0 introduces two major new features: Web Explorer, a data access tool that can be used from an internet browser, and Secure Warehouse, a utility for controlling user access to data warehouses. To incorporate these new features, MetaCube now has the capability of handling connection information for a user differently than it did in previous versions.

In MetaCube 4.0, user information can be stored in two places: the registry of the machine where the MetaCube engine is running and the metadata CLIENT table for the current database connection. The user properties stored in the registry provide default connection information. They allow Web Explorer users to connect to the database via MetaCube. All other user properties are stored in the CLIENT table in the database.

When Secure Warehouse is used to create users, entries for those users are created in the registry of the computer running the MetaCube engine to which Secure Warehouse is connected. Typically that computer is a middle-tier NT server. If there are multiple middle-tier NT servers, entries must be created in the registry of each machine for the users connecting through the MetaCube engine running on that machine.

Users of client / server applications, such as MetaCube Explorer, do not need registry entries to enable a database connection. These applications always set their connection properties explicitly, either through user input or by using the values defined in the client's MetaCube.ini file.

Table 3-1 *Metabase Class of Objects: Properties*

Property	Description/Example
Application	Object: This property returns the application object, that is, the MetaCube engine. This property, though essentially useless, is required by OLE. **MsgBox MyMetabase.Application.Version.**
ClientType	A read-only property that identifies the development environment in which the Metabase object has been instantiated; determines the format in which MetaCube returns strings. See "Related Constants" on page 3-15 for more information on constants. **MsgBox MyMetabase.ClientType**
Configuration	Identifies a set of properties stored as parameters in MetaCube.ini. String. In version 4.0 and later releases of MetaCube, the MetaCube engine does use this property. It is retained, however, for compatibility with previous versions. **MyMetabase.Configuration = "Default"**
ConnectDatabase	Identifies vendor of RDBMS. See "Related Constants" on page 3-15 for more information on vendor constants. If not specified explicitly, this property defaults to Informix. **MyMetabase.ConnectDatabase = DBVendorInformix**
Connected	Indicates whether a Metabase object has connected to RDBMS. Returns true if connected. **If MyMetabase.Connected = True _** **Then MsgBox "Hooray!"**
ConnectString	Identifies an ODBC data source. To establish a database connection, this property must be set explicitly. **MyMetabase.ConnectString = "MetaDemo"**

Table 3-1 *Metabase Class of Objects: Properties (continued)*

Property	Description/Example
CurrentTime	Retrieves current data and time from PC clock. Use with QueryBack. Variant (date). **MsgBox MyMetabase.CurrentTime**
DatabaseDBSpaces	ValueList of all valid dbspaces for the current database connection. The contents of this ValueList are used to make a list of possible dbspaces, from which one can be chosen to store a user's QueryBackJob objects. **MsgBox MyMetabase.DatabaseRoles**
DatabaseRoles	ValueList of all Informix roles defined in metadata. The contents of this ValueList are used to make a list of possible database roles that can be assigned to users managed in MetaCube Secure Warehouse. **MsgBox MyMetabase.DatabaseRoles**
DatabaseUsers	ValueList of all Informix users defined in the database. The contents of this ValueList are used to make a list of possible users, from which users that will be managed in Secure Warehouse are selected. **MsgBox MyMetabase.DatabaseUsers**
DataSkip	This long value property determines whether an Informix RDBMS can skip locked or otherwise unavailable rows when attempting to retrieve data. See constants below. MetaCube enables or disables data skip, as specified, upon connection to an Informix RDBMS. Defaults to 2, the constant for accepting Data Skip default. **MyMetabase.DataSkip = DataSkipOff** For more information, see the DATASKIP entry in the *Informix Guide to SQL: Syntax*.
DataSources	ValueList of ODBC data sources available to MetaCube. The contents of this ValueList are used to make a list of database connections from which a user can select one. **MsgBox MyMetabase.DataSources**

Table 3-1 Metabase Class of Objects: Properties (continued)

Property	Description/Example
Explain	Setting this Boolean property to true prompts an Informix RDBMS to record information such as the execution plan and the cost of each query, as generated by the database-server optimizer, in a server-side file titled sqexplain.out. The default value of this property is false. MetaCube activates this database feature, if requested, upon connection to an Informix RDBMS. **MyMetabase.Explain = True** See the SET EXPLAIN entry in the *Informix Guide to SQL: Syntax* for more information.
LastUpdate	Stores date on which DSS System's metadata was last modified. Variant (date). **MsgBox MyMetabase.LastUpdate**
LocalMetamodelFile	Name of file storing local copy of metadata. Defaults from MetaCube.ini file. String. MyMetabase.LocalMetamodelFile = "MetaCube.DSS"
Login	User name passed to RDBMS for login. Default read from MetaCube.ini. String. **MyMetabase.Login = "MetaDemo"**
MaxTotalFetches	Specifies number of rows MetaCube retrieves before aborting a query. **MyMetabase.MaxTotalFetches = 4000**
MetamodelNames	ValueList of all DSS System names in metadata. With MetaCube 4.0, this property has been replaced by the **Names** property of the DSSSystems collection (that is, Metabase.DSSSystems.Names). **MsgBox MyMetabase.MetamodelNames**
MetaSchema	Identifies a schema (or prefix) for metadata tables. To establish a database connection, this property must be set explicitly. **MyMetabase.Schema = "MetaCube."**

Table 3-1 *Metabase Class of Objects: Properties (continued)*

Property	**Description/Example**
Name	Default property; the name of the DSS System to be created or name of DSS System currently open. String. **MyMetabase.Name = "MetaCube Demo"**
Optimization	This Boolean property determines the extent to which the optimizer of an Informix RDBMS evaluates every possible execution strategy for a SQL query. The default value of true allows the RDBMS optimizer time to consider all reasonable join strategies and indexes. Setting this property to false reduces the time devoted to optimizing SQL queries but may preclude the RDBMS optimizer from deploying the most efficient execution plan. MetaCube sets the optimization level upon connection to an Informix RDBMS. **MyMetabase.Optimization = False** See the SET OPTIMIZATION entry in the *Informix Guide to SQL: Syntax* for more information.
Parent	Returns the application object. Required by OLE for multi-threading. **MsgBox MyMetabase.Parent**
Password	Password submitted to database server. Setting this property through the programming interface does not automatically record a value in MetaCube's initialization file. String. **MyMetabase.Password = "MetaDemo"**

Table 3-1 *Metabase Class of Objects: Properties (continued)*

Property	**Description/Example**
PDQPriority	This property designates the Parallel Data Query (PDQ) Priority of all decision support system queries submitted by MetaCube to the Informix database. PDQ Priorities, which can range from 0 to 100, determine the extent to which the Informix database executes queries in parallel. A value of 0 explicitly precludes any parallel operations, a value of one enables only parallel scans, and values between two and 100 represent the percent of available system resources that queries against this decision support system can consume. In multi-processor systems, high PDQ Priorities enable the database to process queries faster. PDQ Priorities may be limited by environment variables and files established by the database administrator when configuring the Informix RDBMS. The long value of this property defaults to -1, indicating that MetaCube will not set PDQ Priorities. Accept this default when connecting to databases that do not support PDQPRIORITY, such as Microsoft Access and Informix Standard Engine, or when submitting queries to a uniprocessor server. If any value other than the default is specified for this property, MetaCube attempts to set PDQPRIORITY for all queries upon connection to an Informix RDBMS. **MyMetabase.PDQPriority = 50** For more information about PDQPriority, see the *INFORMIX-OnLine Dynamic Server Administrator's Guide*.
PublicUser	Read-only string: Identifies the user empowered to save queries and filters that other users can access in MetaCube Explorer and MetaCube for Excel. This string is set to metapub for current releases of Explorer and MetaCube for Excel. In future releases, this property may be variable, in which case applications should use this property to identify the public user. **MsgBox MyMetabase.PublicUser**
Role	A string containing the database role of the currently connected user. If a user is not connected, the string is empty. **MyMetabase.Role = "Analyst"**

Table 3-1 *Metabase Class of Objects: Properties (continued)*

Property	Description/Example
SuppressDialogs	Boolean: A true value precludes the MetaCube Status window from appearing in your application. Defaults to true. **MyMetabase.SuppressDialogs = True**
Verified	This property stores a long value returned by the Verify method indicating that the metadata definition for a Metabase object is one of the following: ■ completely valid ■ invalid because an object in the collections owned directly or indirectly by the Metabase object is invalid ■ invalid because the Metabase object itself is invalid If you have not invoked the Verify method, this property defaults to VerifiedNever, indicating that the metadata is unverified. The significance of each of the numeric codes stored by the Verified property is explained in Table 3-6 on page 3-16. **MsgBox MyMetabase.Verified**
VerifyResults	This property stores the ValueList returned by the Verify method describing any errors in the Metabase object's metadata. This will not include errors in the metadata for objects owned by the Metabase object. **MsgBox MyMetabase.VerifyResults.TabbedValues**

Metabase Methods

Metabase properties allow you to define or retrieve different characteristics of the Metabase object. Metabase methods allow you to perform different operations on a Metabase, such as logging in, creating a new DSS System, or opening a query. You should already be familiar with the most common Metabase method, the Connect method. The functionality of Metabase methods falls into three categories:

- Connecting and disconnecting to the relational database and opening and closing DSS Systems

- Creating and deleting DSS Systems and subsequently updating the metadata
- Saving queries and opening or deleting saved queries.

Table 3-2 summarizes the Metabase object class's methods.

Table 3-2 *Metabase Class of Objects: Methods*

Method	**Description/Example**
CloseDSSSystem	Closes existing DSS System. **MyMetabase. CloseDSSSystem**
Connect	Logs in to RDBMS; opens a DSS System and implicitly calls the OpenDSSSystem method. **MyMetabase.Connect**
CreateNew	Creates new DSS System. The name of the DSS System is specified by Metabase's Name property. Only users who have been granted access to Secure Warehouse (meaning the property User.SecureUser is set to true) can call this method. **MyMetabase.CreateNew**
DBLogin	Logs in to RDBMS; does not open DSS System. **MyMetabase.DBLogin**
DBLogout	Disconnects MetaCube from RDBMS. **MyMetabase.DBLogout**
DeleteMetamodel	Deletes DSS System from metadata in RDBMS. Arguments: DSS System Name. Only users who have been granted access to Secure Warehouse (meaning the property User.SecureUser is set to true) can call this method. This method immediately deletes a DSS System. You do not have to call Metabase.Save for this method to take effect. Any references to the deleted DSS System as the default DSS System are set to null. **MyMetabase. DeleteMetamodel "Demo"**

Table 3-2 *Metabase Class of Objects: Methods (continued)*

Method	Description/Example
DeleteQuery	Deletes from RDBMS's metadata the definition of a query, as saved by the SaveAs method of the QueryClass of Objects. Arguments: the query's name, as a string; the query's author, as a string; the folder into which the query has been saved, as an object. **MyMetabase.DeleteQuery "Saved Query", _ "MetaDemo", FolderObject**
Disconnect	Closes DSS System; disconnects from RDBMS. **MyMetabase.Disconnect**
DoSQL	Executes a non-SELECT SQL statement. **MyMetabase. DoSQL "CREATE TABLE . . ."**
OpenDSSSystem	Opens the DSS System specified by Metabase.Name. This method is equivalent to OpenDSSSystem2 when that method is set to True. **MyMetabase. OpenDSSSystem**
OpenQuery	Returns an instance of a Query object bearing the definition of a saved query but none of the query's associated data, reports, or charts. Arguments: the query's name, as a string; the query's author, as a string; and the folder into which the query has been saved, as an object. **Set MyQuery = MyMetabase.OpenQuery _ ("Saved Query", "MetaDemo", _ MyMetabase.RootFolder)**
OpenQueryStorage	Returns a structured storage object representing a query object and its result, as saved by the SaveStorage method of the Query Class of Objects. This method, which is actually beyond the OLE paradigm, can only be used in C++ and other development environments that directly support the COM interface.

Table 3-2 *Metabase Class of Objects: Methods (continued)*

Method	**Description/Example**
RemoteConnect	Using a user's connection information stored in the registry, this method connects a remote client, such as a MetaCube Web Explorer, to the RDBMS and opens a DSS System. Arguments: the user's name, as a string; the user's password, as a string; and optionally, a DSS System name, as a string. If no DSS System name is supplied, MetaCube will use the user's default DSS System. **MyMetabase.RemoteConnect "WebUser", _ "Password", "Demo"**
Save	Saves changes in DSS System to RDBMS metadata. Only users who have been granted access to Secure Warehouse (meaning the property User.SecureUser is set to True) can call this method. **MyMetabase.Save**
SaveAs	Saves all metadata in RDBMS describing a DSS System, including folders, filters and queries, under a new name. Arguments: New DSS System Name. Only users who have been granted access to Secure Warehouse (meaning the property User.SecureUser is set to true) can call this method. When you use SaveAs to create a new DSS, remember that initially no users have access to the new DSS System. The data warehouse administrator must give user's access to the new DSS System, or you must use the programming interface to grant access to users. **MyMetabase.SaveAs "New Name"**
Verify	Reviews the metadata definitions represented by the Metabase objects and other objects within its collections or sub-collections, returning values to the Metabase object's Verified and VerifyResults properties. **MyMetabase.Verify**

Related Constants

Table 3-3 summarizes the numeric arguments for the ClientType property, including the names of constants declared in the MetaCons.bas file.

Table 3-3 *Client Type Constants*

Development Environment	MetaCons.bas Constant Name	Constant
Visual Basic	ClientTypeVB	1
Visual Basic for Applications	ClientTypeExcel	2
C	ClientTypeC	3

Table 3-4 summarizes the numeric arguments for the ConnectDatabase property, including the names of the constants declared in the MetaCons.bas file.

Table 3-4 *Database Vendor Constants*

Database Vendor	MetaCons.bas Constant Name	Constant
Microsoft Access	DBVendorAccess	2
Informix Online	DBVendorInformix	5

Table 3-5 summarizes the numeric constants to be specified when setting the DataSkip property.

Table 3-5 *Data Skip Constants*

Data Skip Functionality	MetaCons.bas Constant Name	Constant
Abort query if any requested record is unavailable.	DataSkipOff	0
Skip any unavailable records, returning what values are available.	DataSkipOn	1
Accept database default for Data Skip option.	DataSkipDefault	2

Table 3-6 below shows the numeric arguments returned by the Verify method.

Table 3-6 *Verify Codes*

Verification Status	MetaCons.bas Constant Name	Constant
Object has never been verified	VerifiedNever	0
Object verified successfully	VerifiedGood	1
Object itself verifies, but other objects in its collections or sub-collections do not	VerifiedBadBelow	2
Object itself fails to verify	VerifiedBad	3

Metabase Collections

Figure 1-1 on page 1-9 offers a simplified view of MetaCube's hierarchy of object classes, representing a collection of Queries as the only collection directly descended from the Metabase object. For the purposes of designing the simple query application featured in the preliminary tutorial, a detailed understanding of every collection spawned by the Metabase class of objects was unnecessary. Actually, ten collections belong to the Metabase object, as shown in Figure 1-2 on page 1-10 and described in Table 3-7.

Table 3-7 *Metabase Class of Objects: Collections*

Collection	**Description/Example of Add Method**
Dimensions	Consists of all dimensions in a DSS System. A subset of this collection belongs to the FactTable Class of objects. If an item exists in both collections, deleting an item from this collection also deletes the item from the FactTable objects' collections. To instantiate a Dimension object, you must specify the name of the dimension, its type, the name of the database schema owning the underlying table, the name of the table itself, the name of the column joining that table to the fact table, and the name of the column storing aggregate level information. **MyMetabase.Dimensions.Add** **"Time", DimensionTypeTime, "MetaDemo", _** **"TIME_DIMENSION", "DAY_CODE", "AGG_LEVEL"** See "The Dimension Collection's Add Method" on page 4-4 for more details.
DSSSystems	Consists of all DSSSystem objects in metadata. These objects are loaded after the user connects to the database. This collection does not feature an Add method, as MetaCube generates the items within this collection by reviewing the metadata tables. See "The DSSSystem Class of Objects" on page 10-3 for more details.

Table 3-7 *Metabase Class of Objects: Collections (continued)*

Collection	Description/Example of Add Method
Extensions	Consists of libraries of functions, developed as extensions to MetaCube's analytical engine. Consultants, third-party vendors, and sophisticated customers can develop extensions in C++ from a template provided with MetaCube's analysis engine. The syntax for developing extensions is unrelated to the programming interface of MetaCube's hierarchy of object classes. The code is subsequently compiled in a separate file, which functions like a dynamic link library. Each extension may consist of one or many functions. Any time an application refers to an individual function, the entire extension is invoked. Once developed, extensions are registered through MetaCube's programming interface by instantiating an Extension object, with an argument that identifies the file containing compiled code. **MyMetabase.Extensions.Add _** **"c:\metacube\mcplgmn.mcx"** When instantiating an Extension object, include the name of the extension in MetaCube's initialization file, metacube.ini, enabling the extension whenever MetaCube launches.
FactTables	Consists of all fact tables in this DSS System. To instantiate a FactTable object you must specify the name of the object, the name of the database schema owning the underlying table, and the name of the database table itself that represents the fact table. **MyMetabase.FactTables.Add "Sales Transactions", _** **"METADEMO", "SALES_TRANSACTIONS"** See "The FactTable Class of Objects" on page 6-3 for more details.
Queries	Consists of any saved queries that have been opened during a session. Ad hoc queries are also instantiated and defined within this collection, as shown in MetaCube API Exercise 2 on page 2-7. To instantiate a Query object, specify the name of the new object as an argument to the Add method. **MyMetabase.Queries.Add "My New Query"** See "The Query Class of Objects" on page 8-3 for more details.

Table 3-7 Metabase Class of Objects: Collections (continued)

Collection	Description/Example of Add Method
QueryBackJobs	Consists of all QueryBack jobs for a DSS System that were submitted by this user, both pending and complete. The collection of QueryBackJob objects does not feature a formal Add method, as the Submit method of the Query object actually creates a QueryBack job. See "The QueryBackJob Class of Objects" on page 8-71 for more details.
RootFolder	This is a special type of collection, consisting of only one object, which itself can be the parent of other objects of a similar type. This object is the highest level object representing the storage interface queries and filters saved in MetaCube's metadata. See "The Folder Class of Objects" on page 7-3. This collection does not feature an Add method, as any DSS System can only have one RootFolder object, which exists by default.
Schemas	Consists of all physical database schemas or table owners within the RDBMS and is useful for verifying metadata. This collection does not feature an Add method, as MetaCube generates the items within this collection by reviewing the database's system tables. See "Schemas, Tables, Columns" on page 9-3 for more details.
SystemMessages	Consists of all System Messages for a DSS System. To instantiate a SystemMessage object, deploy the Add method, specifying the text of the message and the date and time of its creation. **MyMetabase.SystemMessages.Add "Data Loaded", _ MyMetabase.CurrentTime** See "The SystemMessage Class of Objects" on page 11-3 for more details.
Users	Consists of User objects representing MetaCube users. To instantiate a new User object, deploy the Add method for the Users collection, specifying the name of the new user. **MyMetabase.Users.Add "New User"** See "The User Class of Objects" on page 10-4 for more details.

The Metabase object’s collections encompass the entire range of MetaCube functionality. The Dimensions and FactTables collections represent a DSS System’s metadata, which describes the Data Warehouse in natural business terms and configures the MetaCube engine to your data model.

Applications such as Warehouse Manager define the properties and invoke the methods of the objects contained within the Dimensions and Fact Tables collections to generate MetaCube’s metadata. Applications such as Explorer review the properties of these objects to display the available attributes and measures on which to query and to filter. The SQL that the MetaCube engine generates depends on the descriptions of fact tables, aggregate tables, dimension tables and attribute tables represented by these collections.

Objects in the FactTables and Dimensions collections thus lay the foundation for your Data Warehouse to process multi-dimensional queries.   Objects in the Filters, Queries, and QueryBackJobs collections actually define those queries in the multi-dimensional terms inscribed by objects in the Dimensions and FactTables collections.

When instantiating a QueryCategory object, for example, you must include an argument identifying the name of an Attribute object. The QueryCategory object belongs to a collection defining the attributes for a particular Query object. The Attribute object belongs to a collection owned by a Dimension object generally defining the available attributes for any query within a particular DSS System.

The RootFolder object class owns hierarchical collections of folders and subfolders by which the storage of Filter and Query objects is organized.

Objects in the Schema collection and their descendants represent a data dictionary of physical schemas, tables, and columns in the relational database. Objects in the Schema collection do not, however, store any of the corresponding multi-dimensional properties of these database structures. As such, this collection exists purely as a reference for supplying values to the properties of objects in the FactTables and Dimensions collection, which map the relationship between physical structures and multi-dimensional terms and logic.

The System Messages collection of objects store string information for distributing information to MetaCube users, such as the status of the database or the maintenance schedule.

The User and DSSSystem collections allow you to manage access to data the same as an administrator would do using MetaCube Secure Warehouse. You can control data by identifying which users can access DSS Systems, assigning mandatory filters to those users to limit what data they can see within a DSS System, and restricting access to QueryBack jobs so users can query data only at certain times.

Chapter

4

The Dimension Class of Objects and Related Collections

This chapter introduces the Dimension class of objects and all the collections directly or indirectly belonging to objects of the Dimension class. The Dimension class and the collections belonging directly or indirectly to it allow you to develop procedures that create, edit, or access MetaCube's metadata.

The Dimension Class of Objects

A Dimension object represents a set of hierarchically-related categories for grouping transactional data. For example, a Dimension Object could represent a Time Dimension, which stores the relationships between days, weeks, months and years.

In Explorer, each dimension appears in a separate listbox, which displays that dimension's attributes. An icon, a default filter, and a set of attribute names are associated with that dimension

Each category, or level in the dimensional hierarchy, corresponds to a DimensionElement object. MetaCube navigates from one level in the hierarchy to another by joining columns represented by a DimensionElement object. Such columns typically identify each value within that hierarchy level by a unique numeric code. Because the user typically never views these codes, only applications performing internal functions on MetaCube's metadata will deploy DimensionElement objects.

Instead, users define the groupings for their queries by attributes, represented by the Attribute object, which store descriptive terms associated with a particular DimensionElement object. We will discuss both dimension elements and attributes as collections that belong to a particular dimension.

The Dimension Collection's Add Method

The add method for the dimension collection requires six arguments, which you must enclose in parentheses to return the instance of the Dimension object to an object variable. Each of the six arguments corresponds to one of the properties listed in and is of the form:

```
MyMetabase.Dimensions.Add Name, DimensionType, Schema, _
    Table, Column, AggLevelColumn
```

where MyMetabase is our instantiation of the Metabase object. The following hypothetical example creates an object for the Time Dimension:

```
Set MyDimension = MyMetabase.Dimensions.Add _
    ("Time", DimensionTypeTime, "MetaDemo", _
    "TIME_DIMENSION", "DAY_CODE",  "AGG_LEVEL")
```

Dimension Properties

The properties of the Dimension object itself largely correspond to the fields in MetaCube Warehouse Manager's Dimension Tab.

Table 4-1 *Dimension Class of Objects: Properties*

Property	**Description/Example**
AggLevel-Column	String. The dimension table column storing aggregate level identifiers, which indicate the row in the dimension table where summary tables can join to find unique values for each dimension element. **MyDim.AggLevelColumn = "Agg_Level"**
Attribute-Names	ValueList of names for all of the dimension's attributes. Arguments: Display type constants, to display items validated for queries, filters, or both. See below. **MsgBox MyDim.AttributeNames (2).TabbedValues**
BaseElement	Object. The dimension element that represents the lowest-level of detail in the dimensional hierarchy. Read-only. **MsgBox MyDim.BaseElement.Name**

Table 4-1 *Dimension Class of Objects: Properties (continued)*

Property	**Description/Example**
Column	String. The dimension table column joining that table to the fact table. This column also typically corresponds to the base dimension element. **MyDim.Column = "DAY_CODE"**
Current-PeriodColumn	String. The column in the dimension table storing the current period flag. Null for non-time dimensions. **MyDim.CurrentPeriodColumn = "CURRENT"**
DefaultFilter	Object. The saved filter for this dimension identified as the default, if a default exists. **MsgBox MyDim.DefaultFilter.Name**
Dimension-Type	Integer. Indicates if a dimension stores time relationships. Time dimensions have different properties and requirements than other dimensions. Default: DimensionTypeNonTime. See tables of constants. **MyDim.DimensionType = DimensionTypeTime**
IconBitmap	String. The icon associated with a dimension is converted from a bitmap to string information, and stored in the database. This value's property is thus the string representation of the icon. **MsgBox MyDim.IconBitmap**
IconName	String. Name of original bitmap file for storing icon that represents this dimension. **MyDim.IconName = "TIME.ICO"**
Name	String. Name of the dimension. Default property. **MyDim.Name = "Time"**
NoFilterLabel	String. A label indicating that no filters have been applied to the parent dimension. No default. **MyDim.NoFilterLabel = "All Products"**
Parent	Object. The Metabase object. **MsgBox MyDim.Parent**
Schema	String. The physical location of the dimension table. **MyDim.Schema = "MetaDemo"**

Table 4-1 *Dimension Class of Objects: Properties (continued)*

Property	Description/Example
Table	String. The name of the dimension table. **MyDim.Table = "TIME_DIM"**
Verified	This property stores a long value returned by the Verify method indicating that the metadata definition for a Dimension object is one of the following: ■ Completely valid ■ Invalid because an attribute or dimension element object belonging to the Dimension object is invalid ■ Invalid because the Dimension object itself is invalid If you have not invoked the Verify method, this property defaults to VerifiedNever, indicating that the metadata is unverified. The significance of each of the numeric codes stored by the Verified property is explained in Table 3-6 on page 3-16. **MsgBox MyDimension.Verified**
VerifyResults	This property stores the ValueList returned by the Verify method describing any errors in the Dimension object's metadata. This will not include errors in the metadata for objects owned by the Dimension object. **MsgBox MyDimension.VerifyResults.TabbedValues**

Dimension Methods

Aside from the **Verify** method, which reviews the validity of the Dimension object's metadata properties, the Dimension class of objects has only one method, the WriteIcon method, which creates an icon from a value stored in the database. Warehouse Manager originally generates the string value from an icon file in order to store the icon's image in the database. Warehouse Manager accomplishes this task by assigning values to two Dimension object properties:

```
MyDimension.IconName = "TIME.ICO"
MyDimension.IconBitMap = "AF50...”
```

The WriteIcon method converts this string value, represented by the Dimension object's IconBitmap property, back to an icon file, as recognized by the IconName property. When invoking this method, you must specify as an argument the directory in which you want the icon file created, as in the following example:

```
    MyDimension.WriteIcon "C:\METACUBE"
```

Related Constants

Table 4-2 summarizes the numeric arguments for the AttributeNames property, including the names of constants declared in the MetaCons.bas file. The MeasureNames property of the FactTable object, which also requires a numeric argument specifying the type(s) of items to display, can use the same constants explained below.

Table 4-2 *Display Type Constants for Attributes and Measures*

Property	**MetaCons.bas Constant Name**	**Constant**
Display items valid for filtering	DisplayStyleFilter	1
Display items valid for querying	DisplayStyleQuery	2
Display items valid for filtering and querying	DisplayStyleBoth	3

Table 4-3 summarizes the numeric argument for the DimensionType property, including the names of constants declared in the MetaCons.bas file.

Table 4-3 *Dimension Type Constants*

Type of Dimension	**MetaCons.bas Constant Name**	**Constant**
Time dimension	DimensionTypeTime	1
Any other type of dimension	DimensionTypeNonTime	0

Dimension Collections

After defining the general characteristics of a dimension, we can specify in greater detail each of the components of a dimension. They are organized into two collections: the dimension elements that define the hierarchy levels within a dimension and the attributes that in turn describe each level. Table 4-4 summarizes these collections:

Table 4-4 *Dimension Class of Objects: Collections*

Collection	Description
Attributes	Consists of the Attribute objects describing every dimension element within this dimension. Each DimensionElement object individually owns a subset of this collection, containing the Attribute objects corresponding to that dimension element.
Dimension-Elements	Consists of a set of hierarchically related DimensionElement objects, each representing a column in the dimension table.

We discuss each of the collections in the pages that immediately follow, beginning with the collection of DimensionElement objects, because Attribute objects belong to collections owned both by Dimension and by DimensionElement objects.

The DimensionElement Class of Objects

As noted previously, a DimensionElement object identifies the column in the relational database defining a particular level in a dimensional hierarchy. This column typically stores a unique code for each value at that level, and can join to fact or summary tables to enable MetaCube to consolidate or group data by higher levels of summarization in the dimension table. By drilling down or up on attribute values associated with a particular dimension element, users can easily navigate through a dimensional hierarchy.

Since most users query on the descriptive terms represented by Attribute objects, front-end applications such as Explorer may never instantiate this object.

The DimensionElement Collection's Add Method

The add method for instantiating a DimensionElement object requires three arguments that correspond to several properties described in the next section. In order of appearance, these arguments are the dimension element's name, the column storing the actual values of the dimension element, which also joins the dimension element to a separate attribute table if it exists, and the identifier within the Aggregate Level column flagging the rows in the dimension element column that store only distinct values of the dimension element:

```
MyDimension.DimensionElements.Add Name,
DimensionToAttributeColumn, AggLevel
```

For example, to add a dimension element named "Brand," stored in a column named "BRAND_CODE" with an aggregate level value of "4," we would enter the following command:

```
MyDimension.DimensionElements.Add "Brand", "BRAND_CODE", 4
```

DimensionElement Properties

Many of a DimensionElement object's properties define the location of the attributes that describe that element. A star model stores attributes in the same table as the columns corresponding to DimensionElement objects, whereas a snowflake model stores attributes in separate tables. MetaCube also supports partial snowflakes, in which the attributes describing some dimension elements are stored in separate tables, while the attributes describing other elements remain in the dimension table.

If attributes describing DimensionElement objects are stored in the same table as the element itself, you need not specify the DimensionElement properties that describe the location of these attributes. If the values of such properties as the AttributeTable property are null, MetaCube assumes the attributes are stored in the table identified by the Dimension object's Table property. Such properties, by default, are empty.

Table 4-5 summarizes the properties of the DimensionElement object.

Table 4-5 *DimensionElement Class of Objects: Properties*

Property	**Description/Example**
AggLevel	A string value, stored in the column identified by the Dimension object's AggLevelColumn property. Indicates at which rows tables can join to dimension tables to find distinct values for a given dimension element. **MyDimEl.AggLevel = "3"**
AttributeSchema	String. In snowflake or partial snowflake data models, the attributes describing a dimension element may be stored in tables separate from the dimension table. This attribute specifies the physical location / schema storing the attribute table for this dimension. **MyDimEl.AttributeSchema = "METADEMO"**
AttributeTable	String. In a snowflake model, the name of the attribute table for this dimension element. **MyDimEl.AttributeTable = "BRANDS"**
AttributeTo-DimensionColumn	String. In a snowflake model, the column in the attribute table used to join that table to the dimension table. **MyDimEl.AttributeToDimensionColumn = _ "BRAND_CODE"**
Base	Boolean. True if the dimension element represents the lowest-level in the dimensional hierarchy, false otherwise. **MyDimEl.Base = True**
DefaultAttribute	Object. Represents the default attribute for the dimension element; displayed when users drill up / down to that element. Read-only. **MsgBox MyDimEl.DefaultAttribute.Name**
Dimension	Object. Identifies the Dimension object to which this element belongs. The Parent property returns the same value, but this property may seem more intuitively named to developers. Read-only. **MsgBox MyDimEl.Dimension.Name**

Table 4-5 *DimensionElement Class of Objects: Properties (continued)*

Property	Description/Example
DimensionTo-AttributeColumn	String. The name of the column in the dimension table storing the actual values of the dimension element. Also, in a snowflake model, the name of the column in the dimension table that joins that table to the attribute table. **MyDimEl.DimensionToAttributeColumn = _ "BRAND_CODE"**
Name	String. Stores the name of the dimension element. Default property. **MsgBox MyDimEl.Name**
Parent	Object. Identifies the Dimension object to which this element belongs. **MsgBox MyDimEl.Parent.Name**
Verified	This property stores a long value returned by the Verify method indicating that the metadata definition for a DimensionElement object is one of the following: ■ completely valid ■ invalid because at least one attribute describing the dimension element is invalid ■ invalid because the DimensionElement object itself is invalid If you have not invoked the Verify method, this property defaults to VerifiedNever, indicating that the metadata is unverified. Verifying dimension elements that have not been incorporated into the dimensional hierarchy returns an error. The significance of each of the numeric codes stored by the Verified property is explained in Table 3-6 on page 3-16. **MsgBox MyDimEl.Verified**
VerifyResults	This property stores the ValueList returned by the Verify method describing any errors in the DimensionElement object's metadata. This will not include errors in the metadata for Attribute objects belonging to the Dimension-Element object. **MsgBox MyDimEl.VerifyResults.TabbedValues**

DimensionElement Methods

The DimensionElement class of objects features only two methods, which either add or remove other elements from a dimension element's consolidation path in the dimensional hierarchy. The **AddDrillUp** method includes a dimension element in the DrillUps collection described on the following page, indicating that the level described by one dimension element exists directly below the hierarchy level of another dimension element.

For example, a DimensionElement object representing days may consolidate to DimensionElement objects representing weeks and months. In this example, weeks themselves do not consolidate to months, as there is not an even number of weeks in each month. Consequently, both weeks and month hierarchy levels sit directly above the day hierarchy level.

Deploying the AddDrillUp method requires you to specify as an argument the DimensionElement object to which you drill up, as shown in this section of sample code:

```
Set DimElLower = MyDimension.DimensionElements.Item("Day")
Set DimElHigher = MyDimension.DimensionElements.Item("Week")
DimElLower.AddDrillUp DimElHigher
```

To remove a DimensionElement object from another DimensionElement object's consolidation path, deploy the RemoveDrillUp method:

```
DimElLower.RemoveDrillUp DimElHigher
```

Please note that an AddDrillDown method does not exist, as MetaCube requires you to describe a hierarchy from the bottom-up such that a single DimensionElement object sits at the base of any dimensional hierarchy.

DimensionElement Collections

Each level in a dimensional hierarchy may be described by many different attributes and may consolidate to several different hierarchy levels. For example, the Brand dimension element may be described by Brand Name and Brand Manager attributes. This element may consolidate to two different levels in the hierarchy, represented by Company and Product Class elements.

The DimensionElement object collections represent the attributes describing a dimension element, the elements directly below the dimension element in the dimensional hierarchy, and the elements directly above the dimension element in the dimensional hierarchy. A DimensionElement object may thus store other DimensionElement objects in a collection. Dimension elements in a simple hierarchy will likely only contain one dimension element in these collections.

Table 4-6 *DimensionElement Class of Objects: Collections*

Collection	Description/Example
Attributes	A collection of Attributes describing the dimension element. **MsgBox MyDimEl.Attributes.Names**
DrillDowns	A collection of DimensionElement objects that exist at hierarchy levels directly below the parent. **MsgBox MyDimEl.DrillDowns.Names**
DrillUps	A collection of DimensionElement objects that exist at hierarchy levels directly above the parent. **MsgBox MyDimEl.DrillUps.Names**

The Attribute Class of Objects

The Attribute class of objects describes in MetaCube’s metadata the descriptive categories by which users define queries. Attributes describe dimension elements and are hierarchically organized in the order of the dimension elements they describe.

The distinction between an Attribute object and a QueryCategory object, which the exercises prominently featured, may confuse some. To incorporate an attribute in the definition of a particular query, you must instantiate a QueryCategory object in a collection owned by a Query object. The Attribute class of objects differs from this QueryCategory class of objects insofar as its properties describe the physical structure of the database. A QueryCategory object can simply identify an Attribute object's name to enable MetaCube to generate SQL on the basis of the Attribute object's properties. The Attribute class of objects thus represents the library of attributes available for a query, whereas the QueryCategory object represents an attribute selected from that library for inclusion in a query's definition.

Although attributes describe a dimension element, you can view the attributes for a single dimension element or for all of the dimension elements in a dimension. Both Dimension and DimensionElement objects own collections of Attribute objects: the DimensionElement object's collection includes only those attributes that describe that dimension element; the Dimension object's collection of attributes owns that dimension element's attributes in addition to attributes describing other elements within the dimension. A DimensionElement object's collection of Attribute objects is thus a subset of the Dimension object's collection of Attribute objects.

The Attribute Collection's Add Method

Although an Attribute object belongs to both a collection owned by a Dimension object and a collection owned by a Dimension Element object, we must instantiate the object as a member of a dimension element's collection, the parent that the attribute actually describes. MetaCube requires two arguments in the instantiation command: the name of the attribute, and the database column storing that attribute's values. In this example, we instantiate an attribute named "Brand Name," the values of which are stored in the column "BRAND_NAME":

```
    MyDimension.Attributes.Add "Brand", "BRAND_NAME"
```

The name of the database table to which this column belongs is specified as a property of the DimensionElement object, if your data model is a snowflake, or as a property of the Dimension object, if your data model is a star.

Attribute Properties

The properties of an Attribute object correspond to many of the fields in Warehouse Manager for an attribute, specifying the physical characteristics of the attribute, balloon help, sample values, and other information about the attribute. Please note that, aside from the standard **Verify** method, the Attribute object has no methods. Table 4-7 summarizes the properties of the Attribute class of objects.

Table 4-7 *Attribute Class of Objects: Properties*

Property	Description/Example
BalloonHelp	String. Stores a brief explanation of the attribute for pop-up balloon help in Explorer and other applications. **MyAttribute.BalloonHelp = "Isn't it obvious, stupid?"**
Column	String. The column in the attribute or dimension table storing the actual attribute values. **MyAttribute.Column = "BRAND_NAME"**
ColumnType	Integer. Identifies the type of data stored in the attribute column: character, numeric, date, or other. See constants below. **MyAttribute.ColumnType = DataTypeNumeric**
Default	Boolean. Indicates whether the attribute represents the default description of a dimension element. MetaCube Explorer displays the default attribute of a dimension element whenever a user drills up or down to that element, but other applications may use this information differently. Complements dimension element's read-only DefaultAttribute property. Defaults to false. As there can only be one default attribute for any given dimension element, setting the Default property of one attribute to True reverts any other attributes within that dimension element's collection to False. **MyAttribute.Default = True**
Description	String. Stores a long description of the attribute for administrative purposes. **MyAttribute.Description = "Data from a legacy system..."**
Dimension	Object. The Dimension object to which the attribute belongs. Read-only. **MsgBox MyAttribute.Dimension.Name**

Table 4-7 *Attribute Class of Objects: Properties (continued)*

Property	**Description/Example**
Dimension-Element	Object. The DimensionElement object described by the attribute; also the direct owner of the attribute's collection, as indicated by the Parent property. Read-only. **MsgBox MyAttribute.DimensionElement.Name**
DisplayStyle	Long. Indicates whether the attribute is valid for display in query and / or filter interfaces. See the display constants listed in Table 4-2 on page 4-7. **MyAttribute.DisplayStyle = DisplayStyleBoth**
Example1	String. Stores a sample value of the attribute in the metadata, which copies to client. Explorer retrieves this value to populate a sample report before executing query. Defaults to empty. **MyAttribute.Example1 = "Alden"**
Example2	String. Stores a second sample value of the attribute. Defaults to empty
Example3	String. Stores a third sample value of the attribute. Defaults to empty.
ListSQL	String. Stores a custom SQL command retrieving the values of the attribute from the database, typically for display as a set of choices on which the user can filter. **MyAttribute.ListSQL = _** **"SELECT * FROM GENDER_VALUES"**
Name	String. Attribute name. Default property. **MyAttribute.Name = "Brand Name"**
Parent	Object. The DimensionElement object that owns the collection to which the attribute belongs. **MsgBox MyAttribute.Parent.Name**
ScreenOrder	Integer. Determines the order in which attributes appear in an interface; defaults to the order of instantiation. **MyAttribute.ScreenOrder = 1**

Table 4-7 *Attribute Class of Objects: Properties (continued)*

Property	**Description/Example**
SortColumn	String. Identifies the name of a numeric column other than the attribute column on which to perform a sort. The column specified is often a sequential dimension element. Instead of sorting attribute values directly, MetaCube can sort a set of values associated with each attribute. If, for example, the column representing a dimension element is identified as the SortColumn for an attribute, MetaCube will sort the attribute values based on the numeric values of the dimension element. Attribute values associated with a dimension element of a low numeric value will appear first, and those associated with a dimension element of a high numeric value will appear last. The attribute values will continue to be displayed in a sorted report, but the column on which the sort is based will not. The SortColumn property is particularly useful for attributes of a time dimension, as different date formats may preclude MetaCube from directly sorting such attributes correctly. MetaCube can accurately sort dates regardless of date format by basing the sort on the sequential dimension element that enumerates each date. Please note that the column identified by this property must be in the same table as the column on which the attribute itself is based. By default, MetaCube sorts on the attribute value itself, in which case this property should remain empty or blank. **MyAttribute.SortColumn = “DAY_CODE”**
ValueList	ValueList. A list of values for this attribute, retrieved by MetaCube and stored in the metadata directly; allows applications to display filter choices rapidly. Read-only. **MsgBox MyAttribute.ValueList.TabbedValues**
Verified	This property stores a long value returned by the Verify method indicating that the metadata definition for an Attribute object is either: ■ completely valid ■ invalid because the Attribute object itself is invalid If you have not invoked the Verify method, this property defaults to VerifiedNever, indicating that the metadata is unverified. The significance of each of the numeric codes stored by the Verified property is explained in Table 3-6 on page 3-16. **MsgBox MyAttribute.Verified**

***Table 4-7** Attribute Class of Objects: Properties (continued)*

Property	Description/Example
VerifyResults	This property stores the ValueList returned by the Verify method describing any errors in the object's metadata. **MsgBox MyAttribute.VerifyResults.TabbedValues**

Table 4-8 summarizes the constants stored by the ColumnType property of the Attribute class of objects.

***Table 4-8** Column Type Properties*

Data Type	MetaCons.bas Constant Name	Constant
Character	DataTypeChar	0
Numeric	DataTypeNumeric	1
Date	DataTypeDate	2
Other	DataTypeUnsupported	3

Attribute Collections

The collections of an Attribute object contain the attributes to which a user can drill from a value of the original attribute. The **DrillUp** collection consists of Attribute objects that you can directly reach by drilling up, whereas the DrillDown collection consists of Attribute objects that you can directly reach by drilling down.

The attributes included in each collection actually depend on dimension elements, which define the actual dimensional hierarchy. Associated with each dimension element is a default attribute, identified as such by the Default property of the Attribute object. When drilling to a new hierarchy level, a user cannot see all of the attributes describing a dimension element, only the default attribute for that dimension element. An attribute's drill collections thus contain only default attributes for dimension elements that sit either directly below or above the original attribute's dimension element in the hierarchy.

For example, a Regional Manager attribute may describe the Region level of detail in a dimensional hierarchy. Directly below the Region dimension element may sit District and City levels of detail, such that both cities and districts consolidate to regions but cities do not roll up to districts, nor vice-versa. If the default attributes for district and city are City Name and District Name, the Attributes objects representing City Name and District Name will belong to a DrillDowns collection owned by the original Attribute object, named Regional Manager.

Table 4-9 summarizes the Attribute object's collections.

Table 4-9 *Attribute Class of Objects: Collections*

Collection	Description/Example
Drill-Downs	A collection of Attribute objects that you can drill down to from the attribute. The attributes in this collection are limited to the default attributes for a set of dimension elements. In the dimensional hierarchy, this set of dimension elements sits directly above the dimension element described by the attribute. A simple hierarchy will feature only one element at the higher hierarchy level and one default attribute describing that element. **MsgBox MyAttribute.DrillDowns.Names**
DrillUps	A collection of Attribute objects that you can drill up to from the attribute. The attributes in this collection are limited to the default attributes for a set of dimension elements. In the dimensional hierarchy, this set of dimension elements sits directly below the dimension element described by the attribute. A simple hierarchy will feature only one element at the lower hierarchy level and one default attribute. **MsgBox.MyAttribute.DrillUps.Names**

Chapter

Extensions

5

This chapter introduces the programming interface for incorporating extensions compiled in C++ into MetaCube. Once an extension has been registered through the programming interface, the functions within that extension can be deployed directly, as if the extension functions were native to MetaCube's analysis engine. This chapter also explains those functions that have been created as standard extensions available with any MetaCube release.

The Extension Class of Objects

Once you have developed and compiled an extension, register the functions of that extension by instantiating an object of the Extension class of objects. Registering an extension incorporates that extension's functionality into MetaCube until that extension is explicitly removed.

Although your instance of the Extension object class may release when your application terminates, instantiating that object appends a permanent entry to MetaCube's initialization file, metacube.ini. This entry, called Enabled Extensions, identifies the file name and path of the extension and appears under the [Engine] header.

Whenever any application calls the MetaCube engine, the engine automatically enables the extensions identified in the metacube.ini file. For each new extension, it is thus necessary to instantiate an object of the Extension Class only once.

The Extensions Collection’s Add Method

To instantiate an object of the Extension class, identify the parent Metabase object, that object’s collection of Extension objects, and deploy the Add method, general to all collections. The Add method requires one argument, the file name of the extension:

```
MyMetabase.Extensions.Add “c:\metacube\mcplgmn.mcx”
```

The specified extension is registered in MetaCube’s initialization file, and is automatically enabled upon all subsequent connections between an application and the MetaCube engine. To disable an extension, deploy the Remove method, also general to all collections:

```
MyMetabase.Extensions.Remove 0
```

You can identify an extension by file name or by index number:

```
Set MyExtension = MyMetabase.Extensions.Item _
                    (“c:\metacube\mcplgmn.mcx”)
```

Since referring to an Extension object by name is often inconvenient, you can store an instance of the object in an object variable such as MyExtension.

Extension Properties

The properties of an object of the Extension class store information about an extension for a programmer's referral, but few, if any of these properties can be usefully incorporated into an application.

Table 5-1 *The Extension Class of Objects: Properties*

Property	**Description/Example**
Arguments	Stores a read-only ValueList of arguments required by each function, in the order in which they are to be specified. When retrieving arguments for a function, the name of the function for which arguments are to be retrieved must be specified. **MsgBox MyExtension.Arguments "FracOTot"**
Argument-Types	Stores a read-only ValueList indicating the type of each argument for a function, compiled in the same order as the arguments to which that list corresponds. When retrieving argument types for a function, the name of the function for which argument types are to be retrieved must be specified. **MsgBox MyExtension.ArgumentTypes "FracOTot"**
Description	Stores a read-only string description of the extension. **MsgBox MyExtension.Description**
Enabled	Stores a Boolean value indicating whether the extension has been enabled. **MsgBox MyExtension.Enabled**
FileName	Stores the file name of the compiled extension code as a read-only string. **MsgBox MyExtension.FileName**
Functions	Stores a read-only ValueList of the functions included in an extension. **MsgBox MyExtension.Functions**
Types	Stores a read-only ValueList of the object classes to which the function applies, typically either the string "QueryCategory" or "QueryItem." **MsgBox MyExtension.Types**

Because many of the properties of the Extension object class return ValueLists including the names or arguments of all functions, application developers may not want to compare such lists against one another to discover the arguments of a particular function.

MetaCube API Exercise 14 on page 5-6 generates a report listing the name of each function, the object class to which that function applies, the arguments required by that function, and the argument types. This program can evaluate any extension, provided the name of the extension and the number of functions included in that extension are accurately specified by the constants ExtensionName and NumberofFunctions.

As shown, the program displays information about the functions of the Main MetaCube Extension. As subsequent exercises deploy these functions, the report generated by this application may be a useful reference when reading later sections of this guide.

MetaCube API Exercise 14: Displaying Functions within an Extension and Displaying Arguments for Those Functions

```
Sub FunctionList()

'Declare Constants
    Const ExtensionName = "c:\metav3\mcplgmn.mcx"
    Const NumberofFunctions = 16

'Declare Variables
    Dim MyMetabase As Object, _
    MyExtension As Object, Count As Integer, _
    FunctionNames As Variant, _
    FunctionTypes As Variant, _
    Arguments As String, _
    ArgumentTypes As String

'Connect
    Set MyMetabase = CreateObject("Metabase")
    MyMetabase.Connect

'Enable Extension, If Necessary
    Set MyExtension = _
        MyMetabase.Extensions.Add(ExtensionName)

'Get Function Names and Types
    Let FunctionNames = _
        MyExtension.Functions.ArrayValues
    Let FunctionTypes = _
        MyExtension.Types.ArrayValues
```

```
'Report Headers
    Worksheets.Item("Sheet1").Activate
    ActiveSheet.Cells(1, 1) = "Function Name"
    ActiveSheet.Cells(1, 2) = "Function Type"
    ActiveSheet.Cells(1, 3) = "Arguments"
    ActiveSheet.Cells(1, 4) = "Argument Types"
'Cycle Through Functions
For Count = 0 To NumberofFunctions
    Let Arguments = _
        MyExtension.Arguments(FunctionNames(Count))
    Let ArgumentTypes = _
        MyExtension.ArgumentTypes(FunctionNames(Count))
    ActiveSheet.Cells(Count + 2, 1) = _
        FunctionNames(Count)
    ActiveSheet.Cells(Count + 2, 2) = _
        FunctionTypes(Count)
    ActiveSheet.Cells(Count + 2, 3) = Arguments
    ActiveSheet.Cells(Count + 2, 4) = ArgumentTypes
Next Count

'Format Report
    ActiveSheet.Range(ActiveSheet.Cells(1, 1), _
        ActiveSheet.Cells(Count + 1, 4)).Select
    Selection.EntireColumn.AutoFit

End Sub
```

The Main MetaCube Extension Functions

Included with every MetaCube executable is the Main MetaCube Extension, a set of standard analytical functions called by MetaCube applications such as MetaCube Explorer and MetaCube for Excel. The file name for this extension, mcplgmn.mcx, can be found in the MetaCube directory. Once this extension has been enabled, you can replace attribute and measure names with complex expressions when instantiating QueryItems and QueryCategories.

As discussed in “The QueryCategory Class of Objects” on page 8-20, Query-Category and QueryItem objects typically refer to the names of attributes and measures, as defined in MetaCube’s metadata by Attribute and Measure objects:

```
MyQuery.QueryItems.Add “Brand”
```

The functions included in an extension perform operations on attribute and measure values, manipulating or pre-processing data before it becomes incorporated as an attribute or a measure in MetaCube’s virtual cube of data.

An extension’s functions can only return values to a QueryCategory or a QueryItem object, and these functions can only be used as expressions when instantiating such objects. When instantiating a QueryItem, the syntax for such an expression is straightforward, with the name of the function and all arguments enclosed in quotation marks, in the same position as the name of a measure. Any arguments required by the function follow the function name, in a list enclosed in parentheses. The syntax is of the general type:

```
MyQuery.QueryItems.Add “FUNCTION_NAME _
    (Argument 1, Argument 2, Argument 3...)”
```

As the framework for developing attribute functions is more deeply embedded in MetaCube and less flexible, no general syntax has been formulated for QueryCategory expressions. Fortunately, application developers are unlikely to encounter major new attribute functions. For an explanation of the two attribute functions available in the Main MetaCube Extension, see “Extension Functions as QueryCategory Expressions” on page 5-40.

The next section explains the functions that can be deployed as QueryItem expressions.

Extension Functions as QueryItem Expressions

The functions included in MetaCube's main extension enable complex statistical comparisons, summations, and averages. Two functions, TOPN and TOPPCT, limit the number of rows displayed in a report to those rows associated with the highest or lowest values of a measure. The TOPN function replaces the TopN object class, which in previous releases belonged to the MetaCube object class.

To help readers understand the operations a function performs on the values of a measure, subsequent sample procedures always include as a separate QueryItem the measure on which the function is being performed. Such pairing is, however, unnecessary. A measure that is otherwise excluded from the query can be included in an expression.

For example, a query can return gross revenues by quarter, the percentage change in operating costs, where gross revenue is a simple measure, and percentage change is a function performed on a second measure, operating costs. In fact, a query could simply return percentage change in operating costs without including any other measures.

Table 5-2 describes each of the functions in the main extension that apply to measures. Each description assumes that measures are organized by columns, their default orientation. A longer explanation of each function follows, discussing how pivoting attributes and measures alters the result returned by the function.

Table 5-2 *Functions as QueryItem Expressions*

Function	Description/Example
ABS_CHANGE	Compares the difference between columns of data. **MyQuery.QueryItems.Add "ABS_CHANGE (Units Sold)"**
FracGTot	Calculates the fraction of a value compared to the sum of all values for every page, column, and row in the report. This fraction can be multiplied by any factor, as specified in the second argument. **MyQuery.QueryItems.Add "FracGTot (Units Sold, 100)"**

Table 5-2 *Functions as QueryItem Expressions (continued)*

Function	Description/Example
FracOTot	Calculates the fraction of a value compared to the sum for the entire row. This fraction can be multiplied by any factor, as specified in the second argument. **MyQuery.QueryItems.Add "FracOTot (Units Sold, 100)"**
FracPTot	Calculates the fraction of a value compared to the sum for the entire page. This fraction can be multiplied by any factor, as specified in the second argument. **MyQuery.QueryItems.Add "FracPTot (Units Sold, 100)"**
FracSTot	Calculates the fraction of a value compared to the sum of the subtotal for that value. Arguments: the measure, the multiplier, and the attribute on which subtotals are being performed. **MyQuery.QueryItems.Add _ "FracSTot (Units Sold, 100, Brand)"**
FracTot	Calculates the fraction of a value compared to the total for a column. This fraction can be multiplied by any factor, as specified in the second argument. **MyQuery.QueryItems.Add "FracTot (Units Sold, 100)"**
MovingAvg	Calculates the average of a value and a specified number of values in preceding rows of the same column. Arguments: measure name and number of values over which to average. **MyQuery.QueryItems.Add "MovingAvg(Units Sold, 2)"**
MovingSum	Calculates the sum of a value and a specified number of values in preceding rows of the same column Arguments: measure name and number of preceding values to sum. **MyQuery.QueryItems.Add "MovingSum (Units Sold, 2)"**
PCT_CHANGE	Calculates the percent change between columns of data. **MyQuery.QueryItems.Add "PCT_CHANGE (Units Sold)"**
PCT_PREV	Calculates a value as a percentage of the value in the preceding column of data. **MyQuery.QueryItems.Add "PCT_PREV (Units Sold)"**

Table 5-2 Functions as QueryItem Expressions (continued)

Function	Description/Example
QUANTILE	For each column, divides values of a column into a specified number of ranked categories according to their magnitude. Arguments: measure name and number of quantiles or categories. **MyQuery.QueryItems.Add "QUANTILE (Units Sold, 3)"**
RUNNINGSUM	Calculates the sum of a value and all values in preceding rows of the same column. **MyQuery.QueryItems.Add "RUNNINGSUM (Units Sold)"**
TOPN	Limits the rows displayed to those associated with the highest or lowest values of a measure. The number of rows in the report is set as an absolute numeric argument. Arguments: measure name, number of rows to display, column number, and ascending / descending flag. **MyQuery.QueryItems.Add "TOPN (Units Sold, 3, 0, Asc)"**
TOPPCT	Limits the rows displayed to those associated with the highest or lowest values of a measure. This function only displays those rows storing values that are within a specified percentage of the highest value in a row or column. Arguments: measure name, percentage, column number, and ascending / descending flag. **MyQuery.QueryItems.Add "TOPN(Units Sold, 34, 0, Asc)"**

The Absolute Change Function

This function compares two or more columns or rows of the same measure, interpolating an additional measure indicating the difference between the two. The AbsoluteChange function only compares columns or rows of data measured in the same units, ignoring intervening columns or rows measured in different units.

If a query’s measures are organized by columns, this function compares numeric data as organized by columns and thus depends on the orientation of at least one attribute by columns. A minimum of two columns of data must be retrieved for the comparison to function. Conversely, if the orientation of measures is by rows, an attribute with at least two values must be also be organized by rows. The only argument for this function is the name of the measure on which it is being performed:

```
MyQuery.QueryItems.Add “ABS_CHANGE (MEASURE NAME)”
```

Please note that this function can be performed on measures otherwise excluded from the query and its resulting report. In such cases, MetaCube retrieves numeric values for the measure on which the function is being performed but only displays the result of the function. For your reference, MetaCube API Exercise 15 develops a simple query using the Main MetaCube Extension’s absolute change function.

MetaCube API Exercise 15: The Absolute Change Function

```
Sub Absolute_Change()
'Declare Variables
    Dim MyMetabase As Object, MyQuery As Object, _
        MyMetacube As Object, MyData As Variant
'Declare Constants
    Const FirstAttribute = "Brand"
    Const FirstPivot = 1    'By Rows
    Const SecondAttribute = "Region"
    Const SecondPivot = 2 'By Columns
    Const Expression = "ABS_CHANGE (Units Sold)"
    Const MeasurePivot = 2 'By Columns
'Connect
    Set MyMetabase = CreateObject("Metabase")
    MyMetabase.Extensions.Add _
        "c:\metacube\mcplgmn.mcx"
    MyMetabase.Connect
'Define Query
    Set MyQuery = MyMetabase.Queries.Add _
        ("My New Query")
    'QueryCategories
        MyQuery.QueryCategories.Add FirstAttribute
        MyQuery.QueryCategories.Add SecondAttribute
    'QueryItems
        MyQuery.QueryItems.Add "Units Sold"
        MyQuery.QueryItems.Add Expression
'Pivoting
    MyQuery.QueryCategories.Item(0).Orientation = _
        FirstPivot
    MyQuery.QueryCategories.Item(1).Orientation = _
        SecondPivot
    MyQuery.ItemOrientation = MeasurePivot
'Get Results
    Worksheets.Item("Query Report").Activate
    Cells.Select
    Selection.ClearContents
    Set MyMetacube = MyQuery.MetaCubes.Add("Data")
    Let MyData = MyMetacube.ToVBArray
    Set ReportRange = ActiveSheet.Range _
        (ActiveSheet.Cells(1, 1), _
        ActiveSheet.Cells _
        (MyMetacube.Rows, MyMetacube.Columns))
    Let ReportRange.Value = MyData
    ReportRange.EntireColumn.AutoFit   'Sizes columns
End Sub
```

Executing this procedure generates the report displayed in Table 5-3.

Table 5-3 *Result of MetaCube API Exercise 15: Brand by Rows, Region by Columns, Measures by Columns*

Region	**Northeast**	**West**	**West**
Brand	Units Sold	Units Sold	ABS_CHANGE (Units Sold)
Alden	1811	2626	815
Barton	1314	1924	610
Delmore	1778	2557	779
Extreme	433	649	216
Lasertech	1105	1665	560
NVD	2719	3788	1069
Onetron	910	1254	344
Suresound	2548	3464	916
Techno	3699	5286	1587

Fraction of Grand Total

For each numeric value of a specified measure within a report, this function calculates the fraction of that value compared to the sum of that measure or expression for all cells, in columns, rows, and pages of the report, multiplying the fraction by a numeric factor specified as an argument to the function.

To see fractional values as a percentage, choose a factor of one hundred. You must also specify the name of the measure or expression on which the calculation is being performed:

```
MyQuery.QueryItems.Add"FracGTot(MEASURE NAME, MULTIPLIER)"
```

Please note that, as with ABS_CHANGE, this function can be performed on measures not otherwise included in the query. In such cases, the data retrieved to perform the calculation is not displayed in the report.

By substituting different constant values in MetaCube API Exercise 15, we can easily develop an application incorporating this function:

```
Declare Constants

    Const FirstAttribute = "Brand"
    Const FirstPivot = 1    'By Rows

    Const SecondAttribute = "Region"
    Const SecondPivot = 2 'By Columns

    Const Expression = "FracGTot (Units Sold, 100)"
    Const MeasurePivot = 2 'By Columns
```

Substituting this code in lines 6 through 11 of MetaCube API Exercise 15 and executing the altered application generates the report displayed in Table 5-4. The values in the FracGTot cells in all rows of both columns sum to one, multiplied by a hundred, the factor specified as the second argument in the FracGTot function.

Table 5-4 *Fraction of Grand Total for a Brand-Region Query*

Region	**Northeast**	**Northeast**	**West**	**West**
Brand	Units Sold	FracGTot (Units Sold, 100)	Units Sold	FracGTot (Units Sold, 100)
Alden	1811	4.581330635	2626	6.643055907
Barton	1314	3.324057678	1924	4.867189476
Delmore	1778	4.497849734	2557	6.468504933
Extreme	433	1.095370605	649	1.641791045
Lasertech	1105	2.795345307	1665	4.211990893
NVD	2719	6.878320263	3788	9.582595497
Onetron	910	2.302049077	1254	3.172274222
Suresound	2548	6.445737415	3464	8.762964837
Techno	3699	9.357450038	5286	13.37212244

Fraction of Orthogonal Total

For each numeric value of a specified measure or expression within a report, this function calculates the fraction of that value compared to all values of that measure or expression within the same row. When measures are organized by column, this function depends on the orientation of at least one attribute by columns; a minimum of two columns of data must be retrieved for the comparison to function. The FracOTot function requires two arguments, the name of the measure or the expression, and the factor by which to multiply the fraction. As before, you need not include in the query the measure on which the function is being performed.

```
MyQuery.QueryItems.Add “FracOTot(MEASURE NAME, MULTIPLIER)”
```

Please note that pivoting measures to the *row* orientation directs the FracOTot function to calculate the fraction of each measure’s value compared to all values of that measure within the same *column*. As this function’s full name—fraction orthogonal to total—implies, this function always derives fractions from the sum of values appearing orthogonal to its own orientation as a measure.

By substituting different constant values in MetaCube API Exercise 15, we can easily develop an application incorporating the FracOTot function:

```
'Declare Constants
    Const FirstAttribute = "Brand"
    Const FirstPivot = 1    'By Rows

    Const SecondAttribute = "Region"
    Const SecondPivot = 2 'By Columns

    Const Expression = "FracOTot (Units Sold, 100)"
    Const MeasurePivot = 2 'By Columns
```

The report generated by the altered application is displayed in Table 5-5. In this report, the sum of the FracOTot values in each row total one, multiplied by one hundred, the factor specified as the second argument in the function. The fraction calculated is thus the fraction of the total for each row, even though measures have been organized by column.

Table 5-5 *Fraction of Orthogonal Total for a Brand-Region Query*

Region	Northeast	Northeast	West	West
Brand	Units Sold	FracOTot (Units Sold, 100)	Units Sold	FracOTot (Units Sold, 100)
Alden	1811	40.81586658	2626	59.18413342
Barton	1314	40.58060531	1924	59.41939469
Delmore	1778	41.01499423	2557	58.98500577
Extreme	433	40.01848429	649	59.98151571
Lasertech	1105	39.89169675	1665	60.10830325
Suresound	2548	42.38190286	3464	57.61809714
Techno	3699	41.16861436	5286	58.83138564

Fraction of Page Total

This function performs the same calculation as the FracGTot function but compares a single value of a measure or an expression to the total of that measure or expression for an entire page, rather than the entire query result. If you have not subdivided a query result into different pages, the FracPTot function will return the same values as the FracGTot function. As with previous functions, you must specify the measure or expression for which you are calculating the fraction and the factor by which that fraction should be multiplied.

```
    MyQuery.QueryItems.Add “FracPTot(MEASURE, MULTIPLIER)”
```

Since Excel cannot display more than a page of results, this function cannot be meaningfully incorporated into a Visual Basic for Applications procedure.

Fraction of Subtotal

This function calculates each value of a specified measure or expression as a fraction of a subtotal for that measure or expression. When measures are organized by columns, a subtotal sums numeric values for a group of rows.

For example, if we subdivide an attribute such as *Brand* by *Region*, we can then sum each brand's total sales for all regions. Instantiating a Summary object, as explained in "The Summary Class of Objects" on page 8-69, interpolates subtotals for each brand.

Within a subtotal, the Fraction of Subtotal function calculates each value as a fraction of that subtotal; if *Brand* sales are subdivided by *Region*, this function calculates regional brand sales as a fraction of the total sales for that brand. We need not include raw sales data or the subtotals of sales to calculate the fractional subtotal for sales.

The function does, however, require that the query organize multiple attributes by rows so that there are clear subdivisions by which to calculate the subtotal and fractional subtotal. Moreover, the Fraction of Subtotal function requires three arguments: the name of the measure or expression on which to base the calculation, the factor by which to multiply the fraction, and the name of the attribute that constitutes the broader grouping in the report.

```
MyQuery.QueryItems.Add "FracSTot(MEASURE NAME, MULTIPLIER,
NAME OF THE SUBDIVIDED ATTRIBUTE)"
```

Please note that pivoting measures to the row orientation directs this function to calculate subtotals on the basis of attributes organized as columns and subcolumns.

With measures in their standard columnar orientation, the Fraction of Subtotal function bases its calculation on fractions of the sums of values within a row, at break points defined by the attribute instantiated first. The constant values substituted in MetaCube API Exercise 15 thus organize both attributes by row, leaving measures in the column orientation:

```
'Declare Constants
    Const FirstAttribute = "Brand"
    Const FirstPivot = 1    'By Rows

    Const SecondAttribute = "Region"
    Const SecondPivot = 1 'By Rows, i.e. subrows

    Const Expression = _
                "FracSTot (Units Sold, 100, Brand)"
    Const MeasurePivot = 2 'By Columns
```

Executing the altered procedure generates a report similar to the one shown in Table 5-6. To illustrate the premise of the Fraction of Subtotal function, the code has further been altered to include the actual subtotal, although such a modification is unnecessary for the function to calculate fractional values and need not be included in your own programs. To learn how to include subtotals in a report, see “The Summary Class of Objects” on page 8-69.

Table 5-6 *Fraction of Subtotal for a Brand-Region Query*

Brand	Region	Units Sold	FracSTot (Units Sold, 100, Brand)
Alden	Northeast	1811	40.81586658
Alden	West	2626	59.18413342
Alden	Total	4437	100
Barton	Northeast	1314	40.58060531
Barton	West	1924	59.41939469
Barton	Total	3238	100
Delmore	Northeast	1778	41.01499423
Delmore	West	2557	58.98500577
Delmore	Total	4335	100
Extreme	Northeast	433	40.01848429
Extreme	West	649	59.98151571
Extreme	Total	1082	100
Suresound	Northeast	2548	42.38190286
Suresound	West	3464	57.61809714
Suresound	Total	6012	100
Techno	Northeast	3699	41.16861436
Techno	West	5286	58.83138564
Techno	Total	8985	100

In Table 5-6, the two regional values of Northeast and West subdivide eight brands, with the Fraction of Subtotal function calculating the fraction each region contributes to the brand's total sales for both regions. For the subtotals interpolated at each break point, the Fraction of Subtotal function always returns a value of 100.

Fraction of Total

This function calculates the value of a measure or expression as a fraction of the total values in a column or row, multiplying that fraction by a factor such as one hundred to return a percentage. With measures in their default orientation as columns, this function operates on measures as they would appear in a column, comparing one value to its total for the column. When measures have been pivoted to rows, the function compares a value to its total for the row in which it would appear. As always, the measure on which the function is being performed need not be included in the query definition. The function requires the same arguments as the FracOTot and FracGTot functions, explained above:

```
MyQuery.QueryItems.Add “FracTot(MEASURE, MULTIPLIER)”
```

Please note that this function and the FracOTot function can be thought of as operating at right angles to one another, such that pivoting measures will cause the FracTot function to return the same values as calculated by the FracOTot function for the original query.

We can illustrate this point by substituting the same measures, attributes, and attribute orientations in procedures featuring FracOTot and FracTot expressions, with the only difference lying in the orientation of measures:

```
'Declare Constants
    Const FirstAttribute = "Brand"
    Const FirstPivot = 1   'By Rows

    Const SecondAttribute = "Region"
    Const SecondPivot = 2 'By Columns

    Const Expression = "FracTot (Units Sold, 100)"
    Const MeasurePivot = 1 'By Rows
```

Substituting the lines above for similar lines in MetaCube API Exercise 15 generates the report displayed in Table 5-7 on page 5-22. Comparing this result to Table 5-5 on page 5-17 confirms that the two functions return the same values when pivoted to opposite orientations.

Table 5-7 *Fraction of Total For a Brand-Region Query, With Measures Pivoted to the Row Orientation*

Brand	Region	Northeast	West
Alden	Units Sold	1811	2626
Alden	FracTot (Units Sold, 100)	40.81586658	59.18413342
Barton	Units Sold	1314	1924
Barton	FracTot (Units Sold, 100)	40.58060531	59.41939469
Delmore	Units Sold	1778	2557
Delmore	FracTot (Units Sold, 100)	41.01499423	58.98500577
Extreme	Units Sold	433	649
Extreme	FracTot (Units Sold, 100)	40.01848429	59.98151571
Lasertech	Units Sold	1105	1665
Lasertech	FracTot (Units Sold, 100)	39.89169675	60.10830325
NVD	Units Sold	2719	3788
NVD	FracTot (Units Sold, 100)	41.78576917	58.21423083
Onetron	Units Sold	910	1254
Onetron	FracTot (Units Sold, 100)	42.05175601	57.94824399
Suresound	Units Sold	2548	3464
Suresound	FracTot (Units Sold, 100)	42.38190286	57.61809714
Techno	Units Sold	3699	5286
Techno	FracTot (Units Sold, 100)	41.16861436	58.83138564

Moving Average

This function averages a measure or expression with preceding values of that measure or expression. If measures are organized by columns, the preceding values of that measure or expression are taken from higher cells of the same column; if measures are organized by rows, the preceding values are taken from cells to the left in the same row. For the initial cell on which an average is to be calculated, there are no preceding cells, so the moving average will simply be the value of that cell for the specified measure. Along with the name of the measure or expression being averaged, the number of preceding values over which to calculate the average is specified as an argument to the function. As always, the measure on which the function is being performed need not itself be included in the query.

```
MyQuery.QueryItems.Add “MovingAvg (MEASURE, # OF VALUES)
```

To demonstrate this function, we can substitute the following constant declarations into MetaCube API Exercise 15, with the Moving Average function as the expression:

```
'Declare Constants
    Const FirstAttribute = "Brand"
    Const FirstPivot = 1     'By Rows

    Const SecondAttribute = "Fiscal Week"
    Const SecondPivot = 2    'By Columns

    Const Expression = "MovingAvg (Units Sold, 3)"
    Const MeasurePivot = 1   'By Row
```

Because moving averages are often calculated as a measure changes over time, the *Fiscal Week* attribute replaces the *Brand* attribute in this query and in the query for the Moving Sum function. Table 5-8 displays the data returned by the modified procedure, including only four of the 26 weeks displayed in the complete report.

Table 5-8 *Moving Average Function for a Brand-Fiscal Week Query (Four Weeks Only)*

Brand	**Fiscal Week**	**94/01/01 - 94/01/07**	**94/01/08 - 94/01/14**	**94/01/15 - 94/01/21**	**94/01/22 - 94/01/28**
Alden	Units Sold	161	141	135	147
Alden	MovingAvg (Units Sold, 3)	161	151	145.6666	141
Barton	Units Sold	115	118	96	96
Barton	MovingAvg (Units Sold, 3)	115	116.5	109.6666	103.3333
Delmore	Units Sold	186	162	161	135
Delmore	MovingAvg (Units Sold, 3)	186	174	169.6666	152.6666
Extreme	Units Sold	*46*	***34***	***27***	**40**
Extreme	MovingAvg (Units Sold, 3)	46	40	*35.66666*	**33.66666**
Lasertech	Units Sold	108	93	83	93
Lasertech	MovingAvg (Units Sold, 3)	108	100.5	94.66666	89.66666
Techno	Units Sold	360	320	294	268
Techno	MovingAvg (Units Sold, 3)	360	340	324.6666	294

Since this query organizes measures by rows, the Moving Average function incorporates preceding values from the same row to calculate the average. For example, to calculate the average brand sales of *Extreme* over three weeks for the week of January 15 - 21, the function averages sales for the week of January 1, the week of January 8, and, of course, the week of January 15. These values appear in italics.

Similarly, to calculate the average weekly sales over a three week period ending the week of January 22 - 28, the function averages sales for the week of January 8, the week of January 15, and the week of January 22. These values appear in bold font. As the function iterates through the weeks, the same value may be included in several averages, which explains why sales for several weeks are displayed in both italics and bold font.

Please note that for the first two weeks of data, the function cannot evaluate the average over three weeks, so it calculates the average for as many weeks as are available.

Moving Sum

This function sums a measure or expression with the preceding values of that measure or expression. The number of preceding values included in the sum is specified as an argument to the function. For each cell in a report for which the moving sum is to be calculated, the preceding values are taken to be the values for the measure or expression that would appear in higher cells of the same column. If measures have been pivoted to a row orientation, the preceding values are taken to be the values for the measure or expression that would appear in the same row and to the left. As always, the measure on which the function is being performed need not be included in the query.

```
MyQuery.QueryItems.Add “MovingSum (MEASURE, # OF VALUES)”
```

Substituting constant expressions in MetaCube API Exercise 15 generates the report displayed in Table 5-9 on page 5-26:

```
'Declare Constants
    Const FirstAttribute = "Brand"
    Const FirstPivot = 1     'By Rows

    Const SecondAttribute = "Fiscal Week"
    Const SecondPivot = 2    'By Columns

    Const Expression = "MovingSum (Units Sold, 3)"
    Const MeasurePivot = 1   'By Rows
```

As before, the *Fiscal Week* attribute has been substituted for *Region*, as moving sums are often calculated over time. Since time periods often appear as different columns in a report, attributes and measures have been pivoted such that the moving sum function sums values appearing in the same row, but preceding columns. Only four of the twenty-six weeks appearing in the complete report are included in Table 5-9.

Table 5-9 *Moving Sum Function in a Brand-Fiscal Week Query (Four Weeks Only)*

Brand	**Fiscal Week**	**94/01/01 - 94/01/07**	**94/01/08 - 94/01/14**	**94/01/15 - 94/01/21**	**94/01/22 - 94/01/28**
Alden	Units Sold	161	141	135	147
Alden	MovingSum (Units Sold, 3)	161	302	437	423
Barton	Units Sold	115	118	96	96
Barton	MovingSum (Units Sold, 3)	115	233	329	310
Delmore	Units Sold	186	162	161	135
Delmore	MovingSum (Units Sold, 3)	186	348	509	458
Extreme	Units Sold	*46*	***34***	***27***	**40**
Extreme	MovingSum (Units Sold, 3)	46	80	*107*	**101**
Lasertech	Units Sold	108	93	83	93
Lasertech	MovingSum (Units Sold, 3)	108	201	284	269
NVD	Units Sold	259	239	214	190
NVD	MovingSum (Units Sold, 3)	259	498	712	643
Techno	Units Sold	360	320	294	268
Techno	MovingSum (Units Sold, 3)	360	680	974	882

In this example, the Moving Sum function calculates at weekly intervals the sum of the past three weeks' sales. If, instead of the *Fiscal Week* attribute, the *Region* attribute had been organized by columns, the function would have returned for each region the sum of that and the two preceding region's sales. The order in which regions are sorted determines the values returned by the function.

In cells for which the specified number of preceding values are not available, the Moving Sum function returns a partial sum. Indeed, for the first cell in each row, the function sums one value, returning unchanged the value of the measure on which the function operates.

Focusing as before on the *Extreme* brand in the third week of the report, January 15-21, we see that the function sums sales for that week and the two preceding weeks. In the fourth week, the function reaches the maximum number of values allowed by the second argument of the expression, three, and excludes the first week's sales from the sum to include the fourth week's sales. Values that are included in the third week's moving sum are italicized, and values included in the fourth week's moving appear in bold font.

Percent Change

This function calculates the percent change between two values of a measure or an expression, comparing every two values that appear in each row of a report according to the formula:

((Second Value/First Value) **-** *1) *100*

Taking the first of two measure values as 100 percent, the function evaluates whether the second measure value is greater or smaller than the first and by what percentage.

Because the function compares columns of data, it returns no values for the first column of data as the function cannot compare that column to any preceding columns.

If measures have been pivoted to the row orientation, this function calculates the percentage change between each pair of cells within the same column of a report, returning its first result for the second rather than the first row of data.

The Percent Change function requires no arguments except the name of the measure on which the function operates.

```
MyQuery.QueryItems.Add “PCT_CHANGE (MEASURE)”
```

Substituting new constant values at the indicated line numbers in MetaCube API Exercise 15 enables us to quickly develop an application demonstrating this function:

```
'Declare Constants
    Const FirstAttribute = "Brand"
    Const FirstPivot = 1      'By Rows

    Const SecondAttribute = "Region"
    Const SecondPivot = 2     'By Columns

    Const Expression = "PCT_CHANGE (Units Sold)"
    Const MeasurePivot = 2   'By Columns
```

Executing the modified procedure returns the report displayed in Table 5-10.

Table 5-10 *Percentage Change Function for a Brand-Region Query*

Region	**Northeast**	**West**	**West**
Region	Northeast	West	West
Brand	Units Sold	Units Sold	Pct_Change (Units Sold)
Alden	1811	2626	45.00276091
Barton	1314	1924	46.42313546
Delmore	1778	2557	43.81327334
Extreme	433	649	49.88452656
Lasertech	1105	1665	50.67873303
NVD	2719	3788	39.31592497
Onetron	910	1254	37.8021978
Suresound	2548	3464	35.94976452
Techno	3699	5286	42.90348743

That all the values returned by the function are positive indicates that sales for the West region are uniformly better than for the Northeast region. Taking the Extreme brand as an example of this trend, we can see that the values returned by the Percentage Change function indicate that the West's sales for that brand are nearly fifty percent greater than the Northeast's sales for that brand.

Please note that reversing the sort of the report so that West appeared first and Northeast second would change the values returned by the function. In fact, all values returned by the function would be negative, as the column associated with larger values would appear first.

Percent of Previous

This function calculates a value of a measure or an expression as a percentage of the previous value in the same row according to the formula:

*(Second Value/First Value) *100*

Please note that the formula of this function differs only slightly from the formula of the Percent Change function. Both functions calculate the fraction of one value as compared to a previous value but the Percent Change formula subtracts one from the fraction before converting to a percentage. When comparing two values, the Percent Change function returns a change, for example, of negative twenty percent, whereas the Percent of Previous function in this example returns a percentage, 80, indicating that the second value is 80 percent of the first.

Like the Percent Change function, the Percent of Previous function compares by default each column of data to its predecessor, returning no values for the first column of data. Pivoting measures prompts this function to compare values across rows rather than columns. The Percent of Previous function requires one argument, the name of the measure or expression on which the function is being performed:

```
MyQuery.QueryItems.Add “PCT_PREV (MEASURE)”
```

Substituting new constant expressions in MetaCube API Exercise 15 enables us to rapidly incorporate this new function in a procedure:

```
'Declare Constants
    Const FirstAttribute = "Brand"
    Const FirstPivot = 1     'By Rows

    Const SecondAttribute = "Region"
    Const SecondPivot = 2    'By Columns

    Const Expression = "PCT_PREV(Units Sold)"
    Const MeasurePivot = 2   'By Columns
```

Executing the procedure generates the report displayed in Table 5-11. Comparing the values returned by the Percent Change and Percent of Previous functions in Table 5-10 and Table 5-11 confirms that the difference between the results of the two functions is always one hundred.

Table 5-11 *Percentage of Previous for a Brand-Region Query*

Region	**Northeast**	**West**	**West**
Brand	Units Sold	Units Sold	PCT_PREV (Units Sold)
Alden	1811	2626	145.0027609
Barton	1314	1924	146.4231355
Delmore	1778	2557	143.8132733
Extreme	433	649	149.8845266
Lasertech	1105	1665	150.678733
NVD	2719	3788	139.315925
Onetron	910	1254	137.8021978
Suresound	2548	3464	135.9497645
Techno	3699	5286	142.9034874

Quantiles

Where the value of a measure or an expression would normally appear in a report, this function assigns a categorical ranking on the basis of that value, indicating the quantile to which that value belongs compared to other values in the same column. If, for example, you were to rank the sales of nine brands into three quantiles (tertiles, to be precise), the brands would be divided into three categories on the basis of their sales, with the top three selling brands assigned a value of one, the next three a value of two, and the last three a value of three.

The function requires you to specify as arguments the measure or expression on which the calculation will be based, and the number of quantiles by which to categorize the values of that measure.

```
MyQuery.QueryItems.Add “QUANTILE (MEASURE, # OF CATEGORIES)”
```

Pivoting measures to a row orientation directs this function to compare the values of a measure or an expression to other values appearing in the same row rather than in the same column.

Substituting new constant expressions in MetaCube API Exercise 15 enables us to incorporate this function as an expression in the standard query on sales, by *Brand* and by *Region*.

```
'Declare Constants
    Const FirstAttribute = "Brand"
    Const FirstPivot = 1     'By Rows

    Const SecondAttribute = "Region"
    Const SecondPivot = 2    'By Columns

    Const Expression = "QUANTILE (Units Sold, 3)"
    Const MeasurePivot = 2   'By Columns
```

Executing the modified procedure creates the report displayed in Table 5-12 on page 5-32. In that report, sales of nine brands are evenly divided into three ranked groups. If row values cannot be evenly divided between the specified number of categorical rankings, the function will assign lower rather than higher rankings, as necessary.

Table 5-12 *Quantile Function for a Brand-Region Query*

Region	**Northeast**	**Northeast**	**West**	**West**
Brand	Units Sold	QUANTILE (Units Sold, 3)	Units Sold	QUANTILE (Units Sold, 3)
Alden	1811	2	2626	2
Barton	1314	2	1924	2
Delmore	1778	2	2557	2
Extreme	433	3	649	3
Lasertech	1105	3	1665	3
NVD	2719	1	3788	1
Onetron	910	3	1254	3
Suresound	2548	1	3464	1
Techno	3699	1	5286	1

Running Sums

This function sums the value of a measure or an expression with all preceding values that would appear in the same column. Unlike the Moving Sum function, which limits the number of preceding values such that one value is subtracted from the sum as another is added, the Running Sum function continuously increments the value returned by the function from the top of the report to the bottom until the last value represents the grand total for that column. The only argument required by this function is the name of the measure on which the function is being calculated:

```
MyQuery.QueryItems.Add “RUNNINGSUM (MEASURE)”
```

Please note that pivoting measures to the row orientation directs this function to increment values along a row rather than down a column. Substituting new constant values in MetaCube API Exercise 15 and executing the modified procedure demonstrates this effect:

```
'Declare Constants
    Const FirstAttribute = "Brand"
    Const FirstPivot = 1     'By Rows

    Const SecondAttribute = "4 Week Period"
    Const SecondPivot = 2    'By Columns

    Const Expression = "RunningSum (Units Sold)"
    Const MeasurePivot = 1   'By Rows
```

As with moving averages and moving sums, running sums are often calculated over time, and so we replace the *Region* attribute with an attribute from the time dimension, *4 Week Period*, and pivot measures such that the function increments values along a row rather than down a column.

The resulting report is displayed in Table 5-13 on page 5-34. That report adds the number of units sold for any brand to corroborate the idea that the value returned by the Running Sum function increases from one four-week period to the next by the volume of sales for each period, giving the total sales to date for that brand at four-week intervals.

Table 5-13 *Running Sum for a Brand-Region Query*

Brand	4-Week Period	94/01/01 to 94/01/28	94/01/29 to 94/02/25	94/02/26 to 94/03/25	94/03/26 to 94/04/22
Alden	Units Sold	584	616	748	219
Alden	RunningSum (Units Sold)	584	1200	1948	2167
Barton	Units Sold	425	418	579	159
Barton	RunningSum (Units Sold)	425	843	1422	1581
Delmore	Units Sold	644	520	762	161
Delmore	RunningSum (Units Sold)	644	1164	1926	2087
Extreme	Units Sold	147	138	195	55
Extreme	RunningSum (Units Sold)	147	285	480	535
Techno	Units Sold	1242	1126	1614	347
Techno	RunningSum (Units Sold)	1242	2368	3982	4329

Top N

This function evaluates the values of a measure or an expression for a specified column, limiting the rows displayed in the entire report to those with the highest or lowest values for that column. For example, this function could limit a query returning brand sales data to three rows, which represent the top three selling brands. The values returned by the function for those brands would simply be sales data.

Since reports often feature multiple columns of data, you must specify the column on which the function should base its selection of the top or bottom rows. If we subdivide brand sales into two columns by region, Northeast and West, the function can limit the query to the top three selling brands in the Northeast region or the top three selling brands in the West region.

Due to this potential ambiguity, the Top N function requires four arguments: the name of the measure or expression to be evaluated for high or low values, the number of rows to include in the report, the column on which to base the function, and a flag, Asc or Desc, indicating whether to take the highest or lowest values. Setting the Desc argument directs the function to choose the lowest rather than the highest values. Asc and Desc are not constant names substituting for a numeric flag but strings understood directly as arguments by the function. The syntax for including this function as an expression when instantiating a QueryItem is:

```
MyQuery.QueryItems.Add _
    “TOPN (MEASURE, # OF ROWS, COLUMN/ROW INSTANCE, _
        Asc/Desc FLAG)”
```

The Column / Row Instance argument identifies the column on which to base the selection of the top or bottom rows by number. Columns are numbered in a report from left to right, beginning with zero, ignoring subdivisions created for different measures. If no attributes have been pivoted to the column orientation, the value for this argument should be zero.

As we subdivide columns by different attribute values, it becomes more difficult to define the basis for choosing the top or bottom rows of data.

Consider the report displayed in Table 5-14. The top brands can be identified on the basis of numeric data for the Northeast or West region, for either 1995 or 1994. For each column, the two highest values are set in bold face. A Top N function that returns revenues for the top two revenue-grossing brands would display different brands, depending on the column specified by the column / row number argument: Alden and Barton were the top-grossing brands in the Northeast region for 1994; but in 1995, Alden and Lasertech were the top grossing brands.

We cannot, however, identify the critical column by the name of a single attribute value, such as Northeast, because multiple attributes may subdivide columns. In this example, we must specify whether the function should return the highest values for the Northeast in 1994 or the highest values for the Northeast region in 1995. And while this query subdivides columns by two attributes, a different query may subdivide columns by three, four, or more attributes.

It is for this reason that we must identify columns by the more flexible convention of index number.

***Table 5-14** Report Subdivided by Different Attribute Values, Measures, With Highest Two Values in Bold for Each Column*

Column #:	**0**		**1**		**2**		**3**	
Region	**Northeast**				**West**			
Fiscal Year	1994		1995		1994		1995	
Brand	Units Sold	Gross Revenue	Units Sold	Gross Revenue	Units Sold	Gross Revenue	Unit Sold	Gross Revenue
Alden	899	3062700	912	3014520	1268	4268520	1358	4494860
Barton	638	688660	676	717500	943	1033420	981	1050360
Delmore	861	191750	917	205850	1226	278400	1331	299600
Extreme	212	371000	221	386750	323	565250	326	570500
Lasertech	519	361700	586	901800	814	581100	851	588750
NVD	1349	218980	1310	220940	1796	287530	1992	320025
Onetron	442	68525	468	74950	2600	99975	654	108750
Suresound	1230	297540	1318	325600	1693	399210	1771	420090
Techno	1817	104024	1882	108175	251	145285	2774	158247

Since the measure on which to base the Top N function is already explicitly specified as an argument, subdivisions created for different measures do not increment the column / row instance. The column / row instance only increments when a new combination of attribute values groups data by columns. In Table 5-14, each such combination is shaded differently. A row at the head of the report identifies the column number.

Since the column / row number depends on the order in which different columns appear, reversing the sort on any attribute with the same orientation as measures changes the basis for defining the top or bottom rows. Please also note that pivoting the orientation of measures to rows directs the function to limit the query result to a certain number of columns, based on the values appearing in the row specified by the column / row number. The column / row number increments in the same way, beginning with the top-most row and going down.

To deploy this function in a procedure, substitute new constants in MetaCube API Exercise 15:

```
'Declare Constants
    Const FirstAttribute = "Brand"
    Const FirstPivot = 1      'By Rows

    Const SecondAttribute = "Region"
    Const SecondPivot = 2     'By Columns

    Const Expression = _
"TOPN (Units Sold, 2, 0, Asc)"
    Const MeasurePivot = 2   'By Columns
```

Executing the modified procedure generates the report displayed as Table 5-15. As the first value of an attribute organized by columns, Northeast occupies the position of the zeroth column, which the column / row number argument specifies as the basis for calculating the top-selling brands.

Table 5-15 *Top-Two Selling Brands for the Northeast Region*

Region	**Northeast**		**West**	
Brand	Units Sold	TOPN (Units Sold, 2, 0, Asc)	Units Sold	TOPN (Units Sold, 2, 0, Asc)
NVD	2719	2719	3788	3788
Techno	3699	3699	5286	5286

After the Top N function evaluates the values of the specified measure, the top or bottom rows are identified and selected, and the function returns the measure values for those rows unchanged. Separately including the measure on which the Top N function is based results in the redundancy seen in Table 5-15.

Top Percentage

This function is identical to the Top N function, but differs in the second argument. The second argument represents the percent by which displayed rows can be less than the highest value. For example, if this function were performed on a column for which the top value was 100, any rows for which the value of that column were 90 or higher would be returned by a TOPPCT function set to 10 percent. This would be true even if the value of all rows for that column were between 90 and 100, in which case the TOPPCT would essentially have no effect. The second argument is thus a number between one and 100 representing a percentage rather than an absolute number.

To deploy this function in a procedure, substitute new constants in MetaCube API Exercise 15:

```
'Declare Constants
    Const FirstAttribute = "Brand"
    Const FirstPivot = 1     'By Rows

    Const SecondAttribute = "Region"
    Const SecondPivot = 2    'By Columns

    Const Expression = _
        "TOPPCT (Units Sold, 50, 0, Asc)"
    Const MeasurePivot = 2  'By Columns
```

Executing this query returns only three rows. The top-selling brand for the specified column "Northeast" is "Techno Components," with sales of 3699. Only two other brands enjoyed sales in the Northeast within fifty percent of 3699 units. Both are included in the report shown in Table 5-16.

Table 5-16 *Brands Within Fifty Percent of the Top-Selling Brand in the Northeast Region*

Region	**Northeast**		**West**	
Brand	Units Sold	TOPPCT (Units Sold, 50, 0, Asc)	Units Sold	TOPPCT (Units Sold, 50, 0, Asc)
NVD	2719	2719	3788	3788
Suresound	2548	2548	3464	3464
Techno	3699	3699	5286	5286

Please note that this function does not limit the number of rows appearing in the report to fifty percent of all rows, in which case the report would have included four or even five rows.

The general syntax for this function is:

```
MyQueryQueryItems.Add “TOPPCT (MEASURE,
% OF ROWS TO DISPLAY, COLUMN/ROW INSTANCE, Asc/Desc FLAG)”
```

Nesting QueryItem Expressions

Any function that performs a calculation on the numeric data represented by a measure can also perform that calculation on the data returned by another function. All of the measure functions in the Main MetaCube Extension can thus be nested one within another. For example, a query requesting the three brands that have experienced the most dramatic change in sales from one period to the next nests the Absolute Change function within the Top N function:

```
MyQuery.QueryItems.Add _
    “TOPN (ABS_CHANGE (Units Sold), 3, 0, Asc)”
```

In this example, MetaCube performs a recursive analysis. For every two columns of raw data, MetaCube first calculates the difference between the two, interpolating a column displaying the result.   MetaCube then identifies the brands for which the first, or zeroth, column of absolute change values are largest, only displaying absolute change values for those brands.

Extension Functions as QueryCategory Expressions

The Bucket and Compare functions embed query capabilities in MetaCube's analysis engine. The Compare function in particular expands the definition of a QueryCategory to include heterogeneous information, requiring MetaCube to issue multiple queries to the relational database, and subsequently to consolidate the result in a single report.

Table 5-17 *QueryCategory Functions*

Function	Description/Example
BUCKET	Sums specific values of a single attribute in user-labeled groups. **MyQuery.QueryCategories.Add "BUCKET _ (Brand, [FirstLabel, list (Techno Components, Suresound)], _ [SecondLabel, [a, f]], [ThirdLabel, other])"**
COMPARE	Retrieves values of multiple attributes. A different filter can be applied to each attribute. **MyQuery.QueryCategories.Add "COMPARE _ (NOSORT [Brand, Video Only], [Product Class, Audio Only])"**

The syntax for each function is explained below. As always, if the instance of the QueryCategory is stored in an object variable, the entire expression must be enclosed in parentheses, as explained in "Declaring MetaCube Object Type Variables" on page 1-14.

Bucket

The Bucket function groups selected values of a single attribute under customized headings, creating a QueryCategory based on that attribute but with entirely different, user-defined groupings. Each grouping is referred to as a bucket. For example, for the *Brand* attribute this function could create a bucket named "My Brands," consisting of the "Alden" and 'Delmore" brands, and another bucket named "Other Brands," consisting of the remaining six brands. The syntax for this function is embedded as an expression when instantiating a QueryCategory:

```
MyQuery.QueryCategories.Add “BUCKET (Brand, [My Brands, list
(Alden, Delmore)], [Larry’s Brands, [ex, su]], [Other Brands,
other])”
```

Each set of brackets defines a bucket, and each bucket defines a row or column in a report. In this example, assuming the QueryCategory has a row orientation, the resulting report features three rows, one showing sales for "My Brands," another the sales for "Larry's Brands," and a third the sales of "Other Brands." The syntax for each bucket is preceded by an argument labelling that bucket with a name. The grammar for specifying the values included within that bucket has three possible components:

- a list, with specific attribute values in parentheses: `[BUCKETNAMEA, list (Alden, Extreme)]`
- a letter or set of letters or numbers in brackets defining a range of values: `[BUCKETNAMEB, [a, z]]`. You may specify the beginning or end of a letter-defined range with multiple letters, requesting, for example, attribute values beginning with "qu" and ending with "th." The syntax for letter-defined ranges can take four possible forms:
  - all values that begin with a letter or set of letters and *before*: `[BUCKETNAMEB, [all, n]]`
  - all values that begin with a letter or set of letters and *after*: `[BUCKETNAMEB, [r, all]]`
  - all values that begin with a letter *between* two letters, including those letters: `[BUCKETNAMEB[o,q]]` and
  - simply all values [all, all];

  Please note that reversing the order in which MetaCube sorts attribute values does not affect buckets defined by letter ranges. If values are numeric, numbers can be substituted for letters, with the obvious caveat that numbers must be provided in their entirety as opposed to a stem of the first digit or digits.
- the category *other*, including all attribute values excluded from other buckets in the expression: `[BUCKETNAMEC, other]`

Although the examples provided here include all three types of buckets, please note that you can include as many or as few of buckets of the same or different types as you require.

Buckets defined using letter- or number-ranges and lists can overlap, including the same attribute value in multiple groupings. If the attribute on which that bucket is based is included as a QueryCategory in a report with the bucket pivoted to the same orientation, the attribute value will appear twice, once for each bucket. The numeric sum of the rows or columns featuring overlapping buckets always increases, as grouping the same transactional data into different buckets repeats values, increasing the total.

The syntax for instantiating a QueryCategory using a bucket expression that includes all three types of buckets can be generalized:

```
MyQuery.QueryCategories.Add “BUCKET (Attribute Name, _
    [Label1, list ("Value1", "Value2",…)], [Label2, _
    [number/letter, number/letter]], [Label3, OTHER])”
```

MetaCube API Exercise 16 on page 5-44, illustrates the deployment of buckets in a simple procedure.

Compare

The Compare function includes the values of multiple attributes in a single QueryCategory, applying to each attribute a different filter. For example, a Compare function could create a QueryCategory representing sales of three brands as well as the sales of two product lines. Two attributes are involved, *Brand* and *Product Line*, and two filters, one limiting the number of brands to only three, the other limiting product lines to only two, resulting in a total of five different groupings.

The resulting report will thus feature five columns or five rows for that QueryCategory, depending on its orientation. To answer this query, MetaCube will issue two queries, one for *Brand*, the other for *Product Line*. Bringing information about both product lines and brands to one report enables analysts to compare seemingly dissimilar groupings.

The Compare function can include any number of attributes, each filtered differently. Moreover, the filters applied to such attributes can limit data by multiple criteria, even including constraints from different dimensions. For example, the filter on Brand could also include a constraint on time, limiting the sales data for those three brands to the most recent six months of sales. Although a filter may be comprised of multiple constraints, you cannot apply more than one filter to a single attribute within a comparison unless you actually compare an attribute to itself, such that the attribute is repeated as an argument but each time with a different filter applied.

The Compare function can be thought of as returning a set of attribute values to a QueryCategory. As such, this function appears as an expression when instantiating a QueryCategory. For each entity included in the comparison, you must specify the name of an attribute followed by the name of the filter to be applied to that attribute. Each entity appears in brackets.

As noted previously, the Compare function can incorporate any number of entities in a single QueryCategory. For each entity included in a comparison, MetaCube must issue a separate SQL statement, consolidating results within MetaCube's analysis engine.

The example provided below applies the *Audio Only* filter to *Brand,* comparing sales for that entity to a second entity in which a *Computer Only* filter is applied to *Product Subclass*:

```
MyQuery.QueryCategories.Add “COMPARE (NOSORT,
[Brand, Audio Only], [Product Subclass, Computer Only])”
```

The first argument indicates whether the values of all entities should be sorted as a group, or whether each entity should remain distinct. In our example, the NOSORT flag directs the function to sort the two entities separately so that brand names appear first and product subclass names second.

Conversely, the SORT flag directs the function to sort all attribute values together, irrespective of the entity to which they belong. Applying an indiscriminate sort to a comparison between brands and product subclasses would, for example, result in a report in which brand names like “Lasertech” appear beside product subclass names like “Laser Disc Players.”

Regardless of whether the entities are sorted separately or together, the actual direction of the sort can be set by assigning a value to the QueryCategory's SortDirection property, as documented in Table 8-7 on page 8-23.

The syntax for a Compare function can be generalized as follows:

```
MyQuery.QueryCategories.Add “COMPARE, (SORT/NOSORT,
[Attribute Name, Filter Name], [Attribute Name,
Filter Name],…)”
```

Please note that if you substitute the word ALL for the filter name, no filter will be applied to the entity.

MetaCube API Exercise 16 illustrates the deployment of both Bucket and Compare expressions in a procedure. The Bucket expression groups brands by their hypothetical brand managers, Brendan and Glenn. The Compare function retrieves brand sales for a region, Northeast, and a city within that region, New York. A Percent of Previous function calculates the fraction of regional sales that can be attributed to New York for both brand managers.

MetaCube API Exercise 16: Buckets and Comparisons

```
Sub Buckets_and_Comparisons()
'Declare Variables
    Dim MyMetabase As Object, MyQuery As Object, _
        MyMetacube As Object, MyData As Variant
    Const OrientationColumn = 2
'Connect
    Set MyMetabase = CreateObject("Metabase")
    Let MyMetabase.Login = “MetaDemo”
    MyMetabase.Extensions.Add _
        "c:\metacube\mcplgmn.mcx"
    MyMetabase.Connect
'Define Query
    Set MyQuery = _ MyMetabase.Queries.Add("Untitled1")
    MyQuery.QueryCategories.Add _
        "BUCKET (Brand, [Glenn's Sales, List(Alden, _
        Barton,Extreme)], [Brendan's Sales, Other])"
    MyQuery.QueryCategories.Add _
        "COMPARE (NOSORT, [Region, Northeast], _
        [City, New York])"
    MyQuery.QueryCategories.Item(1).Orientation = _
        OrientationColumn
    MyQuery.QueryItems.Add "Units Sold"
    MyQuery.QueryItems.Add _
    "PCT_PREV (Units Sold)"
'Get Results
    Worksheets.Item("Query Report").Activate
    Cells.Select
    Selection.ClearContents
```

```
        Set MyMetacube = MyQuery.MetaCubes.Add("Data")
        Let MyData = MyMetacube.ToVBArray
        Set ReportRange = ActiveSheet.Range _
            (ActiveSheet.Cells(1, 1), _
            ActiveSheet.Cells _
            (MyMetacube.Rows, MyMetacube.Columns))
        Let ReportRange.Value = MyData
        ReportRange.EntireColumn.AutoFit

    End Sub
```

Executing this procedure generates the report displayed in Table 5-18, in which brands are grouped into two buckets, labeled Brendan and Glenn, and sales of those brands are evaluated for the Northeast region and the city of New York. A Percent of Previous function compares the two columns of data, indicating the extent to which New York contributes to the sales in the Northeast region of the brands managed by Brendan and Glenn.

Table 5-18 *Report Generated by MetaCube API Exercise 16*

COMPARE (NOSORT, [Region, Northeast], [City, New York])	**Northeast**	**New York**	**New York**
BUCKET (Brand, [Glenn', List(Alden, Barton, Extreme)], [Brendan Sales, Other])	Units Sold	Units Sold	PCT_PREV (Units Sold)
Brendan	3699	1424	38.496
Glenn	3558	1393	39.151

Chapter

6 The FactTable Class of Objects and Related Collections

This chapter introduces the FactTable Class of objects and all the collections either directly or indirectly belonging to objects of this class. The FactTable object class, and the collections belonging directly or indirectly to that class, enable you to develop procedures that create, edit, or access MetaCube's metadata.

The FactTable Class of Objects

A fact table stores all transaction-level data in the Data Warehouse and sits at the center of a star or snowflake model. The FactTable object describes the physical location of this table as well as the dimensions to which it joins, its size, the measures it contains, and other information.

The FactTable Collection's Add Method

To instantiate a FactTable object, we must identify the parent Metabase that owns the collection of Fact Table objects to which this object will belong as well as the following arguments: the name of the newly-instantiated object, the name of the database fact table, and the schema / location of that table. We present these arguments in the format: MyMetabase.FactTables.Add *Name, Schema, Table.*

For example, to instantiate a FactTable object named "Marketing Data Source" based on a table in the METADEMO schema named MARKETING_FACT, we would execute the following command:

```
MyMetabase.FactTables.Add "Marketing Data", _
"METADEMO", "MARKETING_FACT"
```

The arguments of the collection's Add method correspond to Fact Table properties discussed below.

FactTable Properties

Table 6-1 summarizes the properties of the FactTable object class.

Table 6-1 *FactTable Class of Objects: Properties*

Property	**Description/Example**
Cost	Long integer. The performance cost of accessing the fact table, roughly correlated to the size of the table. MetaCube identifies the optimal table from which to return a result by assessing cost. Defaults to the highest possible number. **MyFactTable.Cost = 30000**
IconBitmap	String. Warehouse Manager converts the icon associated with a fact table from a bitmap to string information, and stores this string in the database. This value's property is thus the string representation of the icon. **MsgBox MyFactTable.IconBitmap**
IconName	String. Name of original bitmap file for storing icon that represents this dimension. No default. **MyFactTable.IconName = "CASH.ICO"**
Measure-Names	ValueList of names for all of the fact table's measure's. Arguments: Display type constants to display the items validated for queries, filters, or both. See Table 4-2 on page 4-7. **MsgBox MyFactTable.MeasureNames(2)**
Name	String. The name of the fact table. Default property. **MsgBox MyFactTable.Name**
Parent	Object. The Metabase object owning the collection to which this fact table belongs. **MsgBox MyFactTable.Parent.Name**
Schema	String. The schema/location wherein the fact table physically resides. **MyFactTable.Schema = "METADEMO"**
Table	String. The name of the database table itself. **MyFactTable.Table = "SALES_TRANSACTIONS"**

Table 6-1 *FactTable Class of Objects: Properties (continued)*

Property	Description/Example
TableSize	Long. Stores the precise number of rows in the table, irrespective of other performance issues such as indexing or partitioning. The administrator must enter a value for this property so that MetaCube can compare the size of sample tables to the original fact table and thereby derive the margin of error attributable to such samples. **MyFactTable.TableSize = 12102**
ValidFlag	Boolean. A true value indicates the fact table is valid for querying. False otherwise. Default upon instantiation is false. **MyFactTable.ValidFlag = True**
Verified	This property stores a long value returned by the Verify method indicating that the metadata definition for a fact table is one of the following: ■ completely valid ■ invalid because at least one Aggregate, AggregateMeasure, DimensionMapping, Measure, or Sample object owned by the FactTable object is invalid ■ invalid because the FactTable object itself is invalid. If you have not invoked the Verify method, this property defaults to VerifiedNever, indicating that the metadata is unverified. The significance of each of the numeric codes stored by the Verified property is explained in Table 3-6 on page 3-16. **MsgBox MyFactTable.Verified**
VerifyResults	This property stores the ValueList returned by the Verify method describing any errors in the FactTable object's metadata. This will not include errors in the metadata for other objects belonging to the FactTable object. **MsgBox FactTable.VerifyResults.TabbedValues**

FactTable Methods

Aside from the standard **Verify** method, the Fact Table's only method is the WriteIcon method, which converts the string value of the IconBitMap property to a standard icon file on the client. This method allows you to specify the directory in which to create the icon file, with the MetaCube directory as the default:

```
    MyFactTable.WriteIcon "C:\METACUBE"
```

This method parallels the structure of the Dimension object class's WriteIcon method, discussed in "Dimension Methods" on page 4-6.

FactTable Collections

A FactTable object's collections include objects representing all of the tables and columns from which a query could possibly retrieve data, including the dimension tables to which the fact table joins to consolidate transactional information, the aggregate tables storing summarizations of those transactions, and the columns storing the numerical measures.

Table 6-2 explains each of the FactTable object's collections.

Table 6-2 *FactTable Class of Objects: Collections*

Collection	Description/Example
Aggregates	A collection of objects that describe aggregate tables. Aggregate tables summarize transactions stored in the fact table to deliver better query performance. **MsgBox MyFactTable.Aggregates.Names**
Dimension-Mappings	For each dimension to which a particular fact table joins, there must exist a DimensionMapping object describing the join itself as well as how to display the dimension to users querying that fact table. Because a dimension can join to more than one fact table and because for each fact table an application may present the dimension in a different way, you can define the relationship between a fact table and a dimension separately through the objects in this collection. A fact table's DimensionMapping objects should correspond exactly to a fact table's Dimension objects. **MsgBox MyFactTable.DimensionMappings.Names**

Table 6-2 *FactTable Class of Objects: Collections (continued)*

Collection	Description/Example
Dimensions	A subset of the DSS System's library of available dimensions, consisting of those dimensions to which the fact table joins, that is, a subset of the Dimension objects in a collection owned by a Metabase object. Deleting a dimension from this collection only signifies that the dimension cannot join to the fact table owning the collection. Other fact tables may continue to join to this dimension. However, any changes made to a dimension object within this collection are registered for the entire DSS System. **MsgBox MyFactTable.Dimensions.Names**
Measures	A collection of numeric, additive metrics stored in, or calculated from, columns in the fact table. **MsgBox MyFactTable.Measures.Names**
Samples	Consists of objects describing sample tables. Sample tables store a statistically significant, evenly distributed set of records replicated from the fact table. Sophisticated statistical algorithms enable MetaCube to extrapolate query results within a prescribed range of accuracy from sample tables. Since sample tables are a fraction of the original fact table's size, such tables offer better performance. **MsgBox MyFactTable.Samples.Names**

The Aggregate Class of Objects

This object class describes aggregate tables. Aggregate tables improve query performance by storing summary-level data. It is only a slight simplification to understand each aggregate table as a repository for a certain query result. If a user requests that result or information that can be derived from that result, MetaCube can satisfy his or her request more quickly by retrieving information from the aggregate table.

Of course, a query requesting information at any level of summarization can always retrieve transaction level information from the fact table, consolidating the detail into larger groupings by joining to dimension tables. But scanning and joining large tables poses intractable performance problems. Aggregates enable certain queries to bypass large fact tables and sometimes dimension tables to reduce the number of rows the database must process. In an intelligently aggregated Data Warehouse, only queries requesting detail-level data require fact table processing.

Aggregate tables summarize transactions in the fact table by a complex set of high-level elements in a dimensional hierarchy. For each fact table, there should exist a set of aggregate tables to improve performance for queries against that fact table. Although aggregates improve performance, you need not expose a view of aggregates to users of a MetaCube query application, as MetaCube automatically and transparently routes each query to the optimal aggregate table, if one exists. For each fact table, there should exist a set of aggregate tables to improve performance for queries ostensibly against that fact table.

Each aggregate table is thus associated with both the fact table that it summarizes and its corresponding Aggregate object existing within a collection owned by a FactTable object. Since aggregates are always calculated directly from a fact table, an Aggregate object cannot exist outside of a collection owned by a fact table.

The Aggregate Collection's Add Method

Instantiating an Aggregate object to describe or create a new summary table in the relational database requires you to specify three arguments: the name of the object, the name of the schema / location storing the table represented by that object, and the name of the table itself. For example, to describe table named "SALES_AGG1" in the "METADEMO" schema, we could instantiate a an aggregate object named "Sales":

```
    MyFactTable.Aggregates.Add "Sales", "METADEMO", "SALES_AGG1"
```

The new object will belong to MyFactTable's collection of Aggregate objects.

Aggregate Properties

An Aggregate object's properties can either describe an existing aggregate table, or enable MetaCube to generate the SQL statements to create a new aggregate table. Whereas the values of Dimension and FactTable objects merely describe database tables, the values of an Aggregate object's properties constitute a blue-print for building tables.

In truth, the values of all three object classes' properties populate MetaCube's metadata tables, which traditionally describe the data model. Unlike other object classes, however, the Aggregate object class can generate SQL on the basis of the metadata, in effect reverse-engineering a database table from the metadata description. MetaCube can populate the new table by querying existing fact and dimension tables. If the underlying aggregate table already exists, the values of the Aggregate object's properties as well as its collections will depend on that table's physical characteristics. If the table does not yet exist, the characteristics of that table will depend on the values of the Aggregate object's properties and on its collections.

MetaCube Aggregator, MetaCube's server-side agent for aggregate construction and maintenance, can execute the SQL stored in the Create-Statement and TableOptions properties. Aggregate object properties such as the SchemaPassword property exist to automate the process of actually building the aggregate through Aggregator. You can also execute the SQL MetaCube generates from any other database development environment.

Table 6-3 summarizes the properties of the Aggregate class of objects.

Table 6-3 *Aggregate Class of Objects: Properties*

Property	**Description/Example**
Cost	Long integer: The performance cost of accessing the aggregate table, roughly correlated to the number of rows in the table. MetaCube identifies the optimal table from which to return a result by assessing costs. The values of an aggregate's cost and a fact table's cost should be similarly scaled, so that, for example, the cost of a fact table containing twice as many rows as an aggregate will be twice as high as the aggregate's cost. Defaults to the highest possible number. **MyAggregate.Cost = 30000**

Table 6-3 *Aggregate Class of Objects: Properties (continued)*

Property	**Description/Example**
Create-Statement	String. For any completely-defined Aggregate object, MetaCube can generate SQL to create the physical table that the object ostensibly describes, storing the CREATE statement as a value of this property. In other words, you can instantiate and define an Aggregate object and its collections when the actual aggregate table does not exist and thereby generate the SQL to create the table. MetaCube Aggregator, a server-side agent, can execute this SQL when prompted to do so. The GenSQL method generates the SQL stored by this property. **MsgBox MyAggregate.CreateStatement**
Filter	Filter Object: This read-only property identifies a filter object, which is a collection of constraints by which the aggregate table is partitioned. Each constraint is instantiated as a FilterElement object. The Filter object owned by an aggregate is identical to the Filter object owned by a query, although it cannot be opened or saved. Other properties and methods that normally apply to a Filter object are invalid. Just as you can filter a query, effectively placing a WHERE clause in the SQL retrieving your query result, you can place a constraint within the SQL generated to build and populate an aggregate table. Defaults to empty. **MsgBox MyAggregate.Filter.Name**
LastUpdate	Variant; date: Indicating the date of the aggregate's most recent update, for maintenance purposes. **MsgBox MyAggregate.LastUpdate**
Name	String: The name of the Aggregate object. Default property. **MsgBox MyAggregate.Name**
Parent	Object: The FactTable object owning the collection to which the aggregate belongs. **MsgBox MyAggregate.Parent.Name**
Schema	String: The name of the schema storing the aggregate table. **MyAggregate.Schema = "METADEMO"**

Table 6-3 *Aggregate Class of Objects: Properties (continued)*

Property	Description/Example
Schema-Password	String. A password string for the database schema storing the aggregate, stored in an encrypted format on the database. MetaCube Aggregator requires this password to execute the SQL building the aggregate in that schema. **MyAggregate.SchemaPassword = "WELCOME"**
Table	String: The name of the aggregate table. **MyAggregate.Table = "SALES_AGG9"**
TableOptions	String. Beyond the commands represented by the Create-Statement property, this property stores any database-specific or custom SQL statements necessary to build the aggregate. MetaCube Aggregator executes the TableOptions commands together with the CREATE statement. **MsgBox MyAggregate.TableOptions**
ValidFlag	Boolean: Indicates whether the aggregate is currently valid for queries; defaults to false. **MyAggregate.ValidFlag = False**
Verified	This property stores a long value returned by the Verify method indicating that the metadata definition for an aggregate table is one of the following: ■ completely valid ■ invalid because at least one AggregateMeasure or Aggregate-Group object owned by the Aggregate object is invalid ■ invalid because the Aggregate object itself is invalid If you have not invoked the Verify method, this property defaults to VerifiedNever, indicating that the metadata is unverified. The significance of each of the numeric codes stored by the Verified property is explained in Table 3-6 on page 3-16. **MsgBox MyAggregate.Verified**
VerifyResults	This property stores the ValueList returned by the Verify method describing any errors in the Aggregate object’s metadata. This will not include errors in the metadata for other objects belonging to the Aggregate object. **MsgBox MyAggregate.VerifyResults.TabbedValues**

Aggregate Methods

Aside from the standard **Verify** method, the Aggregate class of object features only one method, GenSQL, which prompts MetaCube to generate SQL from the metadata description of a new Aggregate object. Because the properties and collections of the Aggregate object already specify all of the parameters for creating the database table, this method requires no arguments. GenSQL returns the SQL as a string value:

```
MyAggSQL$ = MyAggregate.GenSQL
```

Aggregate Collections

The Aggregate object is, in large part, defined by several collections of component objects. Table 6-4 summarizes these collections.

Table 6-4 *Aggregate Class of Objects: Collections*

Collection	Description/Example
Aggregate-Grants	A collection of objects representing SQL GRANT statements, which are used for conferring privileges to view aggregate tables. **MyAggregate.AggregateGrants.Add _** **"GRANT SELECT ON sales_agg1 to METADEMO"**
Aggregate-Groups	Each AggregateGroup object identifies a DimensionElement or Attribute object by which data is summarized in the aggregate table. This attribute or dimension element must be included in one of the dimensions to which the fact table joins. The objects in the AggregateGroups collection also identify the column in the aggregate table storing that dimension element or attribute's values. **MyAggregate.AggregateGroups.Add _** **MyDimEl, "BRAND_CODE"**

Table 6-4 *Aggregate Class of Objects: Collections (continued)*

Collection	**Description/Example**
Aggregate-Indexes	A collection of objects storing indexes for a new aggregate table. Aggregator automatically executes the SQL statement creating the index when it builds the aggregate. When instantiating the AggregateIndex object, include the SQL statement as an argument. **MyAggregate.AggregateIndexes.Add _** **"CREATE UNIQUE INDEX myindex ON...", _** **"METACUBE.", ""**
Aggregate-Measures	Each AggregateMeasure object identifies one of the fact table's Measure objects, thereby including that measure in the aggregate table as well. When instantiating this object, you must also identify the column in the aggregate table storing that measure. **MyAggregate.AggregateMeasures.Add _** **MyMeasure, "UNITS_SOLD"**

The AggregateGrant Class of Objects

This object class allows you to define the grants for a new aggregate, which MetaCube Aggregator executes when creating the aggregate table. Aggregate objects that describe existing tables need not include any AggregateGrant objects in this collection, as the necessary grants probably already exist.

Aside from the **Parent** property, which identifies the Aggregate object that owns the AggregateGrant object's collection, the only property of the AggregateGrant object is the **GrantStatement** property. The string value of this property, which you specify as an argument when instantiating an AggregateGrant, is simply the GRANT SQL statement, which MetaCube stores in the metadata tables for MetaCube Aggregator to execute when building the aggregate. An example of this syntax can be found in Table 6-4.

The AggregateGrant object does not feature any collections or methods. Specifically, MetaCube does not include a method for generating GRANT SQL statements. You must formulate them yourself.

The AggregateGroup Class of Objects

Each AggregateGroup object describes one of the dimension elements or attributes by which you summarize data in an aggregate table. Whereas a fact table may define a sales transaction in terms of base dimension elements such as product code or store code, an aggregate table groups sales by brand or by region. As the number of dimensions increases, identifying the optimal level of detail at which to summarize transactions in aggregate tables may become difficult. MetaCube Warehouse Optimizer can analyze your Data Warehouse to recommend the most effective set of aggregates to build.

Aside from the standard **Parent, Verified,** and **VerifyResults** properties, this object class features only two other properties, no collections, and only one method, the **Verify** method. The verification properties and methods evaluate the validity of the metadata defined by an object's other properties, as explained above.

The first property, **Category,** refers to either an Attribute or Dimension-Element object that defines the level of detail for a particular dimension by which metrics are grouped. You must include this argument when instantiating an AggregateGroup object:

```
MyAggregate.AggregateGroups.Add MyFactTable. _
Dimensions.Item(0).DimensionElements.Item(1), "BRAND_CODE"
```

The second argument in this command, a value of the **Column** property, identifies the column in the aggregate table in which the actual dimension element or attribute values are stored.

Please note that an aggregate can group transactions by values of any attribute or dimension element that belongs to a dimension joined to the fact table. Also note that, although MetaCube supports aggregates built on attributes, aggregates that summarize information by dimension element values are much more flexible and powerful, as they can join to dimension tables to process any query requesting a level of summarization equal to or greater than the level stored in the aggregate itself. Since attribute values do not represent a key to any other table, aggregates built by attribute can only process queries requesting data grouped by that particular attribute's values.

Please note that you must instantiate an AggregateGroup object for each dimension element or attribute included in the aggregate table, regardless of whether that table already exists or remains to be built. MetaCube determines an aggregate's level of summarization and its suitability for processing a given query by evaluating the properties of that aggregate's AggregateGroup objects.

The AggregateIndex Class of Objects

The AggregateIndex object stores any indexes you wish to place on a new aggregate table. Although MetaCube cannot generate indexes, MetaCube Aggregator will execute whatever SQL statements are stored in the AggregateIndex object's **IndexStatement** property when building the aggregate table. You need not instantiate AggregateIndex objects for existing aggregate tables, as MetaCube invokes this object only when building new aggregates.

To instantiate an AggregateIndex object you must include the SQL statement creating the index as an argument to the Add method:

```
MyAggregate.AggregateIndexes.Add _
"CREATE UNIQUE INDEX myindex ON table(column)"
```

In addition to the IndexStatement property, the AggregateIndex object includes properties for storing the name of the schema owning the index, as well as any database-specific or custom SQL statements associated with the index.

Table 6-5 summarizes the AggregateIndex object's properties.

Table 6-5 *AggregateIndex Class of Objects: Properties*

Property	**Description/Example**
IndexOptions	String: Stores custom SQL parameters for creating an index. **MsgBox MyAggregateIndex.IndexOptions**
IndexSchema	String: Identifies the schema that owns the index. **MyAggregateIndex.IndexSchema = "METADEMO"**

Table 6-5 *AggregateIndex Class of Objects: Properties (continued)*

Property	Description/Example
Index-Statement	String. The actual SQL statement used to create the index. Default property. See example above.
Parent	Object. Aggregate object. **MsgBox MyAggregateIndex.Parent.Name**

The AggregateIndex object does not feature any methods or collections.

The AggregateMeasure Class of Objects

The AggregateMeasure object identifies a measure either included in an existing aggregate table or that will be included when a new aggregate is built. Together, an Aggregate object's collection of AggregateMeasure objects define the measures stored in an aggregate table. To include calculated measures in the aggregate table, you need only include the measures on which the calculation for that measure is based.

Regardless of whether you are describing an existing aggregate or a new aggregate, you must instantiate an AggregateMeasure for each measure in the aggregate, as MetaCube evaluates the properties of the Aggregate-Measure object when generating SQL for a query.

Please note that an aggregate can only include measures already stored at the transactional level in the fact table. If, for example, a fact table does not store the revenues generated by a transaction, the aggregate table cannot store the revenues generated by a group of transactions.

To identify the measures included in an aggregate table, you must specify the Measure object and the name of the column in the aggregate in which to store the measure identified by the Measure object. Both the Measure object and the column name appear as arguments in the AggregateMeasure collection's Add method:

```
MyAggregate.AggregateMeasures.Add _
MyMetabase.FactTables.Item(0).Measures.Item(2), "SALES"
```

These arguments correspond to the **Measure** and **Column** properties, respectively. The Measure property identifies a Measure object within the FactTable object's collection of Measure objects, and the Column property identifies as a string the name of the column that stores that measure's values in the aggregate table. Once you have instantiated an AggregateMeasure object, you can edit the values of either property to reflect changes to the data model:

```
MyAggregateMeasure.Measure = MyFactTable.Measures.Item(1)
MyAggregateMeasure.Column = "GROSS_REVENUES"
```

Please note that MetaCube currently only supports aggregates that additively summarize or group information. For example, if you build an aggregate summarizing the measure *Sales* by the aggregate group *Brand Code*, the aggregate totals sales for each brand.

Table 6-6 summarizes the properties of the AggregateMeasure object.

Table 6-6 *AggregateMeasure Class of Objects: Properties*

Property	**Description/Example**
Column	String: Stores the name of the aggregate table column storing the measure's values. **MyAggregateMeasure.Column = "GROSS_REVENUES"**
Function	String: Identifies the type of summarization to perform on the measure. Defaults to "SUM," but COUNT, MIN, and MAX functions are also supported. **MyAggregateMeasure.Function = "SUM"**
Measure	Object: Identifies a Measure object from the FactTable collection for inclusion in the aggregate. Default property. **MyAggregateMeasure.Measure = _** **MyFactTable.Measures.Item(1)**
Parent	Object: Aggregate object. **MsgBox MyAggregateMeasure.Parent.Name**

Table 6-6 *AggregateMeasure Class of Objects: Properties (continued)*

Property	Description/Example
Verified	This property stores a long value returned by the Verify method indicating that the metadata definition for an aggregate measure is either: ■ completely valid ■ invalid because the AggregateMeasure object itself is invalid If you have not invoked the Verify method, this property defaults to VerifiedNever, indicating that the metadata is unverified. The significance of each of the numeric codes stored by the Verified property is explained in Table 3-6 on page 3-16. **MsgBox MyAggregateMeasure.Verified**
VerifyResults	This property stores the ValueList returned by the Verify method describing any errors in the AggregateMeasure object's metadata. **MsgBox MyAggregateMeasure.VerifyResults.TabbedValues**

Aside from the standard **Verify** method, AggregateMeasure objects do not feature any methods and do not own any collections.

The DimensionMapping Class of Objects

The DimensionMapping class of objects describes how a particular fact table joins to a dimension table and how to display that dimension table in interfaces. Whereas the Dimension object itself defines a dimension generally, the DimensionMapping object defines a dimension's particular relationship to a fact table.

For each Dimension in a FactTable object's collection, there must exist a corresponding DimensionMapping object describing the relationship between the two. By describing the relationship between dimensions and fact tables in a separate object, MetaCube enables you to join a dimension to two different fact tables, even though the dimension may join to a different column in each fact table or it should be displayed in a different position for each fact table.

For example, since the relationships between days, weeks, months, and year hardly vary from one type of data to another, you may want to join a Time dimension table to both a sales and a marketing fact table. The Dimension object defines the Time dimension, but the DimensionMappings object defines how that dimension joins to each fact table.

When a user chooses to query one of the two fact tables, a property of the DimensionsMapping object can determine how to display the dimension in the ensuing query interface. Explorer prompts a user to make just such a choice in the Choose Data Source Window, in which each data source corresponds to a different fact table and its associated dimensions.

DimensionMapping Properties

DimensionMapping objects underpin Warehouse Manager's Fact Table Dimensions. The properties of a DimensionMapping object parallel the fields of Warehouse Manager's Fact Table Dimension frame. Table 6-7 summarizes the DimensionMapping object's properties.

Table 6-7 *DimensionMapping Class of Objects: Properties*

Property	Description/Example
Dimension	Object: Identifies an existing dimension object to which the other properties of the DimensionMapping object apply. Default property. **My MyDimensionMapping.Dimension = _ MyFactTable.Dimensions.Item(0)**
FactTable-Column	String: Identifies the column in the fact table to which the dimension joins, typically via a base dimension element. **MyDimensionMapping.FactTableColumn = "STORE_CODE"**
Parent	Object: The FactTable object. **MsgBox MyDimensionMapping.Parent.Name**

Table 6-7 *DimensionMapping Class of Objects: Properties (continued)*

Property	Description/Example
ScreenOrder	Integer: Determines the order in which Explorer displays the specified dimension for a given data source / fact table. Other MetaCube query applications can also retrieve this integer value to determine the order in which their interfaces display dimensions for a given fact table. **ActiveSheet.ListBoxes.Add _** **((MyDimensionMapping.ScreenOrder * 80), 50, 70, 100)**
Verified	This property stores a long value returned by the Verify method indicating that the metadata represented by a DimensionMapping object is either: ■ completely valid ■ invalid because the DimensionMapping object itself is invalid If you have not invoked the Verify method, this property defaults to VerifiedNever, indicating that the metadata is unverified. The significance of each of the numeric codes stored by the Verified property is explained in Table 3-6 on page 3-16. **MsgBox MyDimensionMapping.Verified**
VerifyResults	This property stores the ValueList returned by the Verify method describing any errors in the DimensionMapping object's metadata. **MsgBox MyDimensionMapping.VerifyResults.TabbedValues**

Aside from the standard **Verify** method, the DimensionMapping object does not feature any methods, nor does it own any collections.

The Dimension Class of Objects, as Owned by a FactTable Object

The collection of Dimension objects owned by a particular FactTable object is a subset of the collection owned by a Metabase object and consists of only those dimensions within the DSS System to which the underlying fact table joins. The DimensionMapping collection of objects determines which Dimension objects are included in this collection. The DSS System identified by a Metabase object thus includes a library of dimensions, all or only some of which may join to one of the fact tables within that dimension.

All of the properties, methods, and collections related to the Dimension class of objects apply to the object regardless of whether it is identified as a member of a collection owned by a FactTable object or by a Metabase object. However, deleting a DimensionMapping object from a collection owned by a FactTable object only signifies that a particular fact table does not join to that dimension, whereas deleting a Dimension object from a Metabase object's collection of Dimension objects collection deletes the Dimension object generally.

For a full discussion of the Dimension object, its properties, methods, and collections see "The Dimension Class of Objects" on page 4-3.

The Measure Class of Objects

The Measure object represents a type of additive, numerical data stored in the fact table and its aggregates. Examples of a measure in the demonstration Data Warehouse include *Units Sold*, and *Gross Revenues*. Each Measure object corresponds to a column in the fact table storing values of that measure for each transaction or to a calculation based on other Measure objects representing columns in the fact table.

The Measure Collection's Add Methods

To instantiate a standard Measure object, you must specify the name of the measure, and its definition:

```
MyFactTable.Measures.Add _
"Units Sold", "SUM(COLUMN('UNITS_SOLD'))"
```

The first argument identifies the name of the object; the second provides the name of the column in the fact table storing that measure. Once instantiated, this object remains in memory and is saved as metadata only when the Metabase object saves any changes made to the entire DSS System. Both arguments correspond to properties of the Measure object, as explained in the next section.

A separate instantiation method, AddUserMeasure, creates a user-defined Measure object, which is available only to the author, as identified by his or her login, and which can be deployed on-the-fly. This method, which requires the same arguments as the standard Add method, creates a Measure object that is otherwise indistinguishable from a standard Measure object:

```
MyFactTable.Measures.AddUserMeasure _
"My Units Sold", "SUM(COLUMN('UNITS_SOLD'))"
```

The application need not save the entire DSS System to the database to register the measure. A special method, SaveUserMeasure, performs this task:

```
MyFactTable.Measures.Item “My Units Sold” _.SaveUserMeasure
```

Aside from the standard Verify method, the Measures class of objects does not feature any other methods, nor does it own any collections.

Measure Properties

The properties of a Measure object specify a column in the fact table storing that measure's values or store a formula based on columns in the fact table. These properties also determine which measures are displayed in query and filter interfaces, their order of appearance, and their format. Table 6-8 summarizes the Measure object's properties.

Table 6-8 *Measure Class of Objects: Properties*

Property	**Description/Example**
BalloonHelp	String: A brief explanation of the measure's significance to end-users; used in balloon help messages such as those available in Explorer. **MyMeasure.BalloonHelp = "The sales metric, stupid!"**
Calculated	Boolean, read-only: stores a true value if the measure is derived from a formula, false if the measure directly accesses data stored in columns of fact and aggregate tables. **MsgBox MyMeasure.Calculated**
Constraint	FilterElement Object: Identifies a constraint to apply against the values of a calculated measure to preclude returning undesirable records, such as negative numbers or zero. For a discussion of measure constraints, see the *MetaCube Warehouse Manager's Guide*. FilterElement objects are discussed in "FilterElement Class of Objects: Properties" on page 8-36. **MyMeasure.Constraint.FilterElements.Add _** **"Units Sold", ">", "0"**
Definition	String. The definition of this measure, which can identify a column in the database storing a measure or define a formula based on other measures. To identify a measure stored in a column, follow the example provided on the previous page. Each term within a formula must be preceded by the syntax "SUM," "MIN," "MAX," "COUNT" or "AVG" with the argument of that function in parentheses. Each measure is identified by the syntax "FACT," followed by the name of the measure in single quotes and parentheses. Accepted operators are +, -, / , and *. See the *MetaCube Warehouse Manager's Guide* for more details. **MyMeasure.Definition = _** **"FACT('Gross Revenue')-FACT('{Profit')"**

Table 6-8 *Measure Class of Objects: Properties (continued)*

Property	**Description/Example**
DisplayStyle	Long: Indicates whether the measure is valid for display in a query interface, a filter interface, or both. Defaults to both. For a listing of numeric values and their significance as arguments, see the DisplayStyle constants in Table 4-2 on page 4-7. **MyMeasure.DisplayStyle = 2**
FormatString	String: identifies the default format of the measure. The report application or control interprets the contents of the string, and the syntax varies accordingly. The example pictured here conforms to Microsoft Excel syntax, which is also understood by Explorer's reporting controls. For a comprehensive treatment of this topic, see "The FormatString and FormatStrings Properties: An Overview" on page 8-25. **MyMeasure.FormatString = "#,##0.00"**
Name	String: The name of the Measure object. The default property. **MyMeasure.Name = "Net Profit"**
Parent	Object. The FactTable object owning the collection to which the Measure object belongs. **MsgBox MyMeasure.Parent.Name**
ScreenOrder	Long: Stores a value for ordering the appearance of measures in a listbox or any other interface control. **MyMeasure.ScreenOrder = 2**
UserMeasure	Boolean, read-only: stores a true value if the Measure object is user-defined, false otherwise. **MsgBox MyMeasure.UserMeasure**
Valid	Boolean: A true value indicates the syntax of the measure definition is valid. Read-only. **MsgBox MyMeasure.Valid**

Table 6-8 *Measure Class of Objects: Properties (continued)*

Property	Description/Example
Verified	This property stores a long value returned by the Verify method indicating that the metadata definition for a measure is either: ■ completely valid ■ invalid because the Measure object itself is invalid If you have not invoked the Verify method, this property defaults to VerifiedNever, indicating that the metadata is unverified. The significance of each of the numeric codes stored by the Verified property is explained in Table 3-6 on page 3-16. **MsgBox MyMeasure.Verified**
VerifyResults	This property stores the ValueList returned by the Verify method describing any errors in the Measure object's metadata. **MsgBox MyMeasure.VerifyResults.TabbedValues**

MetaCube API Exercise 17 illustrates how to define and deploy a user-defined measure.

MetaCube API Exercise 17: User-Defined Measures

```
Sub User_Defined_Measure()

'Declare Variables and Constants
Dim MyMetabase As Object, MyQuery As Object, _
    MyMeasure As Object, MyMetaCube As Object, _
    MyData As Variant, ReportRange As Range

'Login
Set MyMetabase = CreateObject("Metabase")
MyMetabase.Connect

'Create User-Defined Measure
Set MyMeasure = MyMetabase.FactTables _
    .Item("Sales Transactions").Measures _
    .AddUserMeasure("Sales by Half", _
    "FACT('Units Sold')/2")
MyMeasure.SaveUserMeasure
MsgBox MyMeasure.Calculated
MsgBox MyMeasure.UserMeasure
```

```
17  'Define Query
18  Set MyQuery = MyMetabase.Queries.Add("Untitled1")
19  MyQuery.QueryCategories.Add "Brand"
20  MyQuery.QueryItems.Add "Units Sold"
21  MyQuery.QueryItems.Add "Sales by Half"

22  'Build Report
23  Set MyMetaCube = MyQuery.MetaCubes.Add("Report1")
24  Worksheets.Item("User Measures").Activate
25
26  'Transform Data in Cube into VB Array
27  Let MyData = MyMetaCube.ToVBArray

28  'Import Data into Excel Spreadsheet
29  Set ReportRange = _
30      ActiveSheet.Range _
31      (ActiveSheet.Cells(1, 1), _
32      ActiveSheet.Cells _
33      (MyMetaCube.Rows, MyMetaCube.Columns))
34  Let ReportRange.Value = MyData
35  ReportRange.EntireColumn.AutoFit  'Sizes columns

36  End Sub
```

Explanation of MetaCube API Exercise 17

This exercise instantiates a Measure object as a private, user-defined object, available for immediate deployment in a query. In lines 2 through 5 we begin the procedure by declaring a set of object variables to store the Metabase, Query, and MetaCube objects necessary to define and to execute a query. We also declare the object variable MyMeasure, which will store the user-defined Measure object, and a set of variables for storing data in a Visual Basic array and subsequently displaying that data in a range of spreadsheet cells.

Lines 7 through 8 establish a multi-dimensional interface to the relational database, opening the DSS System identified in the “Demo” configuration.

Once connected, we can define a new measure in one of two ways. Instantiating a Measure object using the standard Add method creates a measure available to all users but first requires us to save the Metabase object. The AddUserMeasure method of instantiation, shown on lines 10 through 13, creates a private measure available for immediate use. Users who connect to the relational database using a configuration with a different login will not be able to access this measure. In all other respects, a user-defined Measure object is identical to a Measure object instantiated in the usual way; it has all the properties and methods of the object class.

The AddUserMeasure method requires two arguments, the name of the user-defined measure and its definition. We call the measure, “Sales by Half,” a name to which we subsequently refer when instantiating a QueryItem on line 19. The definition itself consists of a simple calculation in which we halve values of the Units Sold measure. The syntax for the definition of measures, which can be verified using the Measure object’s verify property, is documented in the *MetaCube Warehouse Manager’s Guide*.

Rather than saving an entire set of Metadata, we can register the measure as available by deploying the SaveUserMeasure method, as shown on line 14. The Message Boxes displayed by lines 15 and 16 both return true values, the first indicating that our new measure is a calculated measure, the second indicating that this measure is user-defined.

Once the measure has been saved, we can immediately define a query incorporating that measure. The QueryItem object on line 20 refers to the user-defined measure in the standard way, by name, and the remainder of the procedure executes the query using syntax that should be familiar from the tutorial at the beginning of this documentation. Please note that this procedure requires you to name a spreadsheet “User Measures” prior to execution.

The Sample Class of Objects

Sampling improves query performance by orders of magnitude, extrapolating results from tables that are a fraction of the size of the original fact table. The Sample object class describes such tables, which contain a statistically significant, evenly distributed set of records replicated from the fact table.

The Sample Collection's Add Method

After creating a sample table, register that table in MetaCube's metadata by instantiating an object of the Sample class. The Add method for the Samples collection requires three arguments: the name of the logical object, the name of the table-owner or schema to which the underlying sample table belongs, and the name of the sample table itself.

```
MyMetabase.FactTables.Item(0).Samples.Add _
    "Glenn's Sample", "METADEMO", "SALES_SAMP1"
```

As you would expect, instantiating a sample object assigns values to several properties of that object, documented below. To remove a Sample object, identify the Samples collection and deploy the Remove method, general to all collections, specifying the Sample object to be removed by index number.

Sample Properties

Unlike aggregate tables, the physical structure of which depends on the level of summarization, sample tables always feature the same columns as the fact table, differing only in the number of rows they store. Because the structure of the sample table is not subject to variation, the object that defines the metadata for a sample table has few properties.

Table 6-9 summarizes the properties of the Sample object class.

Table 6-9 *Sample Class of Objects: Properties*

Property	**Description/Example**
Name	String: the name of the Sample object. As with the same property of the Aggregate object, the name of the logical object is largely irrelevant since users and even application developers never need specify a sample by name when defining a query. **MySample.Name = "Hardly Matters"**
Schema	String: the name of the table-owner or schema to which the sample table belongs. **MySample.Schema = "METADEMO"**
Table	String: Identifies the underlying sample table by name. Please note that, aside from the table's cost, no other information regarding column names or contents need be included for the sample table, as its structure is completely derived from the fact table. **MySample.Table = "SALES_SAMP1"**
TableOptions	String: Includes any SQL syntax to be appended to the CREATE statement executed by MetaCube Sampler when creating the Sample Table. **MySample.TableOptions = "EXTENT SIZE 20"**
TableSize	Long: The number of rows in a table. This value enables MetaCube to identify which sample can deliver the specified degree of accuracy for a query. MetaCube does not evaluate the costs of aggregates or of the fact table when processing a query against a sample table. **MySample.TableSize = 4003**
Valid	Boolean: A true value indicates the availability of a sample table. Defaults to false. **MySample.Valid = True**
ValueList	ValueList. A list of values for this sample, retrieved by MetaCube and stored in the metadata directly; allows applications to display filter choices rapidly. Read-only. **MsgBox MySample.ValueList.TabbedValues**

Table 6-9 *Sample Class of Objects: Properties (continued)*

Property	**Description/Example**
Verified	This property stores a long value returned by the Verify method indicating that the metadata definition for a Sample object is either: ■ completely valid ■ invalid because the Sample object itself is invalid If you have not invoked the Verify method, this property defaults to VerifiedNever, indicating that the metadata is unverified. The significance of each of the numeric codes stored by the Verified property is explained in Table 3-6 on page 3-16. **MsgBox Sample.Verified**
VerifyResults	This property stores the ValueList returned by the Verify method describing any errors in the object's metadata. **MsgBox MySample.VerifyResults.TabbedValues**

The Sample object class features no methods and owns no collections. Related properties and methods of Query and MetaCube object classes determine which table MetaCube attempts to extrapolate a result from, as well as the range of error associated with such an extrapolation.

In choosing a sample table, MetaCube weighs both of the following:

- the accuracy specified for the query, represented by the Accuracy property of the Query object class
- the table size of the sample relative to other sample tables, represented by the TableSize property of the Sample object class

The Accuracy property of a query stores an integral number between 1 and 100, indicating the relative size of the sample against which MetaCube processes a query. Any value less than the default of 100 prompts MetaCube to process the query against a sample table.

The accuracy requested for the query determines the sample table from which MetaCube should extrapolate a result, but the accuracy value itself bears no absolute statistical relevance. High accuracies prompt MetaCube to choose the largest available sample tables, low accuracies prompt MetaCube to choose the smallest available sample tables. If the largest sample table still does not contain a significant fraction of the total records, the margin of error will be great even for a query requesting a high accuracy.

The correspondence between accuracy and the sample table chosen depends on the total number of tables and on the rank of the chosen table's size as compared to other sample tables. If there exist five tables sampling the fact table, MetaCube processes queries requesting an accuracy greater than 80 against the largest sample table, queries requesting an accuracy greater than 60 against the second-largest sample table, queries requesting an accuracy greater than 40 against the third-largest sample table, and so on. In this hypothetical example, removing any one of the five sample tables changes the accuracy offered by each of the four remaining tables to a range of 25 rather than 20. Queries requesting a low accuracy will process more quickly, as MetaCube can extrapolate results from a smaller table.

A query's assigned accuracy thus directs how MetaCube processes a query, but does not reflect the precision of the extrapolated result. For each result, MetaCube also returns the margin of error. In assigning an error range for each value in the result set, MetaCube evaluates:

- the confidence with which it must predict that the actual result lies within the calculated range, represented by the Confidence property of the Query object class
- the size of the chosen sample as compared to the fact table, again represented by the TableSize property of the Sample and also FactTable object classes
- the relative data density for each attribute included as a QueryCategory; that is, the number of values at the lowest level of the dimensional hierarchy as compared to the level of the specified attribute

The CellError property and the ErrorVBArray, ErrorSpreadClip, and Fetch-CellError methods of the MetaCube object class retrieve for each value presented in the report the associated range of error. Sampling thus involves three object classes: the Sample object class, which defines the metadata for the sample table, the Query object class, which defines queries against sample tables, and the MetaCube object class, which retrieves extrapolated query results and the associated margin of error.

MetaCube API Exercise 18 incorporates all three object classes into a procedure that first defines the metadata for a sample, and subsequently extrapolates results from that sample for a query requesting less than complete accuracy.

Although this exercise registers a new sample in MetaCube's metadata, this change is temporary, as the metadata is not saved, and the Sample object is abandoned at the close of the procedure. The code for registering a sample in MetaCube's metadata is included here only for completeness; most systems, including the demonstration database, will already feature registered sample tables, and queries for which estimates are acceptable will automatically be routed to the appropriate sample table.

For this particular procedure to work, a sample table named SALES_SAMP1 must exist, and the value of the TableSize property must be corrected to reflect the number of rows in that table.

MetaCube API Exercise 18: Sampling

```
Sub Sampling()
'Declare Variables
    Dim MyMetabase As Object, MySample As Object, _
    MyQuery As Object, MyMetacube As Object, _
    MyData As Variant
'Connect
    Set MyMetabase = CreateObject("Metabase")
    MyMetabase.Connect
'Define Metadata for Sample Table
    Set MySample = _
  MyMetabase.FactTables.Item("Sales Transactions") _
  .SAMPLES.Add("Sample", "^Access^", "SALES_SAMP1")
    Let MySample.TableSize = 4003
    Let MySample.Valid = True
    MyMetabase.Save
```

```
16 'Define Query
17     Set MyQuery = MyMetabase.Queries.Add("My New Query")
18     MyQuery.QueryCategories.Add "Brand"
19     MyQuery.QueryItems.Add "Units Sold"
20     Let MyQuery.Confidence = 50
21     Let MyQuery.Accuracy = 5
22     MsgBox MyQuery.SQL 'See query hit sample table
23 'Prepare Worksheet
24     Worksheets.Item("Query Report").Activate
25     Cells.Select
26     Selection.ClearContents
27 'Get Extrapolated Results
28     Set MyMetacube = MyQuery.MetaCubes.Add("Data")
29     Let MyData = MyMetacube.ToVBArray
30     Set ReportRange = ActiveSheet.Range _
31         (ActiveSheet.Cells(1, 1), ActiveSheet.Cells _
32         (MyMetacube.Rows, MyMetacube.Columns + 4))
33     Let ReportRange.Value = MyData
34 'Display Error Just Below Results, Recycle Same Variables
35     Let MyData = MyMetacube.ErrorVBArray
36     Set ReportRange = _
37  ActiveSheet.Range(ActiveSheet.Cells(1, 3), _
38  ActiveSheet.Cells(MyMetacube.Rows, _
39  MyMetacube.Columns + 2))
40     Let ReportRange.Value = MyData
41     ReportRange.EntireColumn.AutoFit  'Sizes columns
42 End Sub
```

Explanation of MetaCube API Exercise 18

This procedure begins by declaring the standard set of object variables for connecting to a decision support system, building a query, and defining a report. An additional object variable, MySample, is declared on line 3 to store an object of the Sample class.

Lines 10 to 12 instantiate a Sample object, assigning the object itself a name, “Sample,” and identifying the table that the object represents, “SALES_SAMP1,” as well as the table-owner or schema to which that table belongs. Since the demonstration database does not support table-owners, the table-owner is identified as “^Access^”.

Line 13 assigns a value to the TableSize property, indicating the number of rows in the table. In the demonstration database, the table SALES_SAMP1 has 4003 rows. Line 14 validates the sample, and line 15 saves the metadata, registering this description of the sample table in the relational database.

Lines 16 to 19 define a query requesting unit sales by brand, a confidence of fifty percent, and an accuracy of five. Setting a low accuracy ensures that our relatively small sample table will be used to process the query. We can confirm that the query accesses data in our new sample table by reviewing the SQL displayed in the Message Box created by line 22.

The query executes on line 29, which requests that the data be returned from the database as an array. The query result is stored in variant, MyData, which we use to populate a range of cells in lines 29 to 32.

The same variables for storing the data and defining a range are given new values in the subsequent section, which begins on line 34. This section of code retrieves the margin of error associated with each value in the query result, displaying the error in a set of cells offset by two columns from the original report. Line 35 converts into an array the error calculated for each extrapolated value, returning zeros for non-numeric cells within the report. Lines 37 to 39 define a range in which to display the error, incrementing the starting and ending positions of the report by two, a seemingly arbitrary number chosen because the original report includes only two columns and we now want to add another two columns for the error.

Adding the numbers returned by the ErrorVBArray method to the values extrapolated for brand sales defines the upper range of MetaCube's estimate; subtracting the same numbers returns the lower range of MetaCube's estimate. As MetaCube based the calculations of these ranges in part on the Confidence property of the Query object—which in our procedure stores a value of 50—there is at least a fifty percent chance that the precise result lies within this range. In fact, only one of the eight actual brand values falls outside the estimated range.

The SampleQualifier Class of Objects

Sample objects can own a single collection of objects, those belonging to the SampleQualifiers class. Each object of this class stores an index or grant that the sampling agent executes as separate SQL statements following the creation of the sample table. Please note that table options appended to the end of the CREATE statement are stored by the TableOption property of the Sample object in MetaCube's programming interface.

To instantiate a SampleQualifier object, specify the SQL statement building an index or granting access privileges and indicate whether that statement should be displayed as an index or a grant in different tools' interfaces:

```
MySample.Qualifiers.Add _
    ("GRANT SELECT ON SAMPLE_TABLE TO USER", "GRANT")
```

The first argument can be any SQL statement stored as a string. The second argument is a string that can store one of two values: "GRANT" or "INDEX." While MetaCube may accept other string values for the second argument, such values will not be registered correctly with Warehouse Manager and Agent Administrator, the applications for managing sample tables.

SampleQualifier Properties

Objects of the SampleQualifier class have two properties, the values of which are assigned upon instantiation. Table 6-10 summarizes these properties.

Table 6-10 *SampleQualifier Properties*

Property	**Description/Example**
Statement	This read-write property stores as a string the SQL statement to be executed following the creation of a sample table. **Let MySampleQualifier.Statement = _** **"GRANT SELECT ON SAMPLE_TABLE TO USER"**
Tag	This read-write property stores as a string the type of SQL statement represented by the Statement property of the SampleQualifier object: **Let MySampleQualifier.Tag = "GRANT"** MetaCube tools understand only two strings, "INDEX" and "GRANT".

Chapter

The Folders Class of Objects

7

This chapter introduces the Folders class of objects, which provides an interface for storing query and filter definitions. Like UNIX, DOS or Windows platforms, all of which support hierarchically organized folders or directories, MetaCube folders can be associated with query and filter objects as well as with other folder objects. A folder can own query and filter definitions, but a folder can also own other folders.

The Folder Class of Objects

As with all objects, the Folder object simply provides an interface for MetaCube functionality. The actual definitions of queries and filters continue to be stored in MetaCube's metadata tables, but the Folder programming interface offers developers and users a familiar paradigm for organizing that information.

Although the idea of folders may be completely familiar to users of most operating systems, as an object in MetaCube's OLE library they differ in three respects from other object classes:

- The RootFolder object owns the first collection of Folder objects. A single RootFolder object belongs to each instance of a Metabase object. You cannot instantiate another RootFolder object.
- The only collection belonging to a Folder object is another collection of Folder objects. Because each Folder object can, in turn, own a collection of Folder objects, the number of collections is unlimited.
- The level of a collection of Folder objects varies, with some collections belonging directly to the RootFolder object, and others removed from the RootFolder object by one or more collections.

As shown in the next section, the Folder class of objects' varying parentage complicates the syntax for instantiating an object of this class.

Instantiating a Folder Object

As noted previously, each Metabase object's root folder owns a collection of folders, and each folder can in turn can own a collection of folders, and so on. The syntax for instantiating a Folder object will depend on the parent of the Folder object:

```
MyMetabase.RootFolder.Folders.Add "My Objects"
MyMetabase.RootFolder.Folders.Item _
    ("My Objects").Folders.Add "New Filters"
MyMetabase.RootFolder.Folders.Item _
    ("My Objects").Folders.Item _
("New Filters").Folders.Add "Time Filters"
```

Storing instantiations of Folder objects in object variables simplifies the syntax for creating subfolders or subdirectories, achieving an identical result with better performance:

```
Set Level1Folder = MyMetabase.RootFolder.Folders.Add _
    ("My Objects")
Set Level2Folder = Level1Folder.Folders.Add ("New Filters")
Set Level3Folder = Level2Folder.Folders.Add ("Time Filters")
```

Once you have instantiated a folder, users can house saved queries in that folder, specifying the folder object itself as an argument to save methods for queries and filters, as documented in Table 3-2 on page 3-12 and "Filter Methods" on page 8-33.

To eliminate a folder, deploy the collection's Remove method, identifying the folder to be removed by name or by index number. To identify the names of the folders in a particular collection, retrieve the contents of the Names property of the Folders collection, a ValueList that defaults to a tab-delimited string. As a collection, Folder objects possess the same properties and methods as other object collections, which are described in "Object Class Hierarchies and Collections" on page 1-6.

Folder Properties

The properties of a Folder object store the name of the folder, and the names of the queries and filters housed in that folder. Table 7-1 summarizes the properties of the Folder class of objects.

Table 7-1 *Folder Class of Objects: Properties*

Property	Description/Example
FilterNames	This read-only property stores the names of filters associated with a folder, an owner, and a group. The owner is the login of the user who saved those filters. The arguments are the name of the owner and the name of the group, both as strings. To view the values of this property, enter a pair of empty double-quotes for the group argument. A ValueList is returned, which defaults to a tab-delimited string. **MsgBox MyFolder.FilterNames "MetaDemo", "Time"**
Name	Stores the name of the folder. **Let MyFolder.Name = "Glenn"**
QueryNames	This read-only property stores the names of queries associated with a folder and an owner. The owner is often the login of the user who saved the queries. You must specify the name of the owner as a string argument to this property. Returns a ValueList, which defaults to a tab-delimited string. **MsgBox MyFolder.QueryNames "MetaDemo"**

Folder Methods

The Folder class of objects features two methods, one for renaming queries associated with a Folder object, and the other for renaming filters associated with a Folder object. Table 7-2 summarizes the methods of the Folder class of objects.

Table 7-2 *Folder Class of Objects: Methods*

Property	Description/Example
FullPathName	Returns a string containing the full path to a Filter object.

Table 7-2 *Folder Class of Objects: Methods*

Property	**Description/Example**
FullPathName	This method returns the full path to a Folder object, which may be useful when manipulating mandatory filters (which are typically assigned in MetaCube Secure Warehouse). You must specify as an argument the name of the Folder object for which a full path is needed. **UserFolderPath = MyFolder.FullPathName("AnotherFolder")**
RenameFilter	Substitutes a new name, group, and / or owner for any one of the Filter objects housed in that folder. The method requires six arguments: the first three are the current owner, group, and name of the filter, the second three are the new owner, group, and name of the filter. **MyFolder.RenameFilter _** **"informix", "Product", "Brand Filter",_** **"metapub", "Time", "Week Filter"**
RenameQuery	Substitutes a new name and / or a new owner for any one of the Query objects housed in that filter. The method requires four arguments: the first two are the current owner and name of the query, the second two are the new owner and name of the query. **MyQuery.RenameQuery "informix", "Old Query", _** **"metapub", "New Query"**

MetaCube API Exercise 19 provides an overview of the major object classes, methods, and properties necessary for creating folders, saving queries and filters in those folders, renaming filters and queries, and, finally, opening those objects again.

MetaCube API Exercise 19: Saving Queries and Filters to Folders; Renaming, Opening Queries and Filters from Folders

```
Sub Folders()

'Declare Variables
Dim MyMetabase As Object, Level1Folder As Object, _
    Level2Folder As Object, Level3Folder As Object, _
    MyQuery As Object, MyFilter As Object, _
    SavedQuery As Object

'Login as MetaDemo
Set MyMetabase = CreateObject("Metabase")
Let MyMetabase.Login = "MetaDemo"
MyMetabase.Connect

'Create Folders
Set Level1Folder = MyMetabase.RootFolder.Folders.Add _
    ("Objects Folder")
Set Level2Folder = Level1Folder.Folders.Add _
    ("Filter Objects Folder")
Set Level3Folder = Level2Folder.Folders.Add _
    ("Product Filter Folder")

'Define and Save Query
Set MyQuery = MyMetabase.Queries.Add("New Query")
MyQuery.QueryCategories.Add "Brand"
MyQuery.QueryItems.Add "Units Sold"
MyQuery.SaveAs "API Query", Level1Folder

'Define and Save Filter
Set MyFilter = MyQuery.Filters.AddNewFilter _
                ("Alden Filter")
Let MyFilter.Group = "Product"
MyFilter.FilterElements.Add _
                "Brand", "=", "Alden"
MyFilter.SaveAs "Alden Filter", Level3Folder

'See List of Queries and Filters Saved in Different Folder
MsgBox MyMetabase.RootFolder.Folders.Names
MsgBox Level1Folder.QueryNames("MetaDemo")
MsgBox Level3Folder.FilterNames("MetaDemo", "")

'Rename Queries and Filters
Level1Folder.RenameQuery _
            "MetaDemo", "API Query", _
            "metapub", "Public Query"
Level3Folder.RenameFilter _
            "MetaDemo", "Product", "Alden Filter", _
            "metapub", "Product", "Alden Filter"
```

```
40 'Display New Contents of Folders:  Objects by metapub
41 MsgBox Level1Folder.QueryNames("metapub")
42 MsgBox Level3Folder.FilterNames("metapub", "")

43 'Open Saved Query, Applying Saved Filter
44 Set SavedQuery = _
45     MyMetabase.OpenQuery _
46     ("Public Query", "metapub", Level1Folder)
47 SavedQuery.Filters.AddSaved _
48     "Alden Filter", "metapub", Level3Folder

49 End Sub
```

Explanation of MetaCube API Exercise 19

The exercise begins by declaring object variables to store Metabase, Query, Filter, and Folder objects. Two object variables, MyQuery and SavedQuery, are declared to store Query objects: one defines and saves the original instance of the Query class of objects, the second stores the definition of that same query as retrieved from the metadata. Since the original query definition remains in memory, the second object variable is unnecessary. Two different object variables are used for clarity, demonstrating explicitly how to save and open queries in a single procedure.

Lines 7 to 10 instantiate a Metabase object and establish a connection between MetaCube and the demonstration database. The Login property of the Metabase object explicitly identifies the user that will later be used as the default author of all saved queries and filters.

After connection, the procedure creates several folders for storing saved queries and filters. Each Metabase object owns a RootFolder object, which in turn owns a collection of Folder objects. Line 12 instantiates a Folder object in this collection called “Objects Folder.” In turn, line 14 instantiates a Folder Object owned by the “Object Folder” called “Filter Objects Folder.” Line 16 instantiates a third Folder object as a subdirectory of that “Filter Objects Folder.” For convenience, each Folder object is assigned to an object variable. When saving and opening queries and filters, we will refer to the objects stored in these object variables as arguments to different methods.

Lines 19 to 21 define a simple query, and line 22 saves the query under the name “API Query” in the folder titled “Object Folder.” Similarly, lines 24 to 28 define a filter on brands, assigning the filter to a group including other filters on attributes of the product dimension. Line 29 saves the filter in the folder titled “Product Filter Folder.” Since we saved the query before defining the filter, the saved query definition does not include any filters. When opening the query again, we will have to open the filter as well as apply that filter to the opened query.

Line 31 displays in a MessageBox the names of the folders in the collection owned directly by the RootFolder object. Unless folders have been created previously, only one folder, Objects Folder, belongs to that collection. Line 32 displays the queries within this folder that were saved to the database by the MetaDemo user. Line 33 identifies the filters saved in this folder by the MetaDemo user. Passing an empty string as the second argument to this property includes filters from all groups, regardless of the dimension to which they belong. All arguments are enclosed in parentheses for these properties because each property returns values to a MessageBox procedure.

Lines 35 to 37 rename the query saved on line 22, first specifying its original owner and name and then assigning a new owner, “metapub,” and a new name, “Public Query,” to the query definition. Switching the owner to “metapub” renders the query available to all Explorer and MetaCube for Excel users. Similarly, lines 38 and 39 rename the filter saved on line 29, assigning a different owner to the filter but otherwise leaving the name and the group unchanged.

Lines 41 and 42 confirm that the author of both query and filter have changed, polling the metadata to determine the names of any queries and filters saved by the “metapub” user to the “Objects Folder” and the “Product Filter Folder,” respectively. Lines 44 to 48 open the saved query and the saved filter, even though the original definition remains in memory, simply to demonstrate the syntax for opening queries and filters. In both cases, the name under which the definition was saved, the login of the author, and the folder object housing that definition are specified as arguments. Because the query definition is returned to an object variable, the arguments for opening a query are included in parentheses.

Chapter

8

The Query and QueryBack Classes of Objects and Related Collections

This chapter explains the Query and QueryBack classes of objects and their related properties, methods, and collections. The sample exercises included in the tutorial at the beginning of this reference demonstrate how you can deploy many of these objects in your own applications.

The Query Class of Objects

Once you have described the tables in your Data Warehouse as multi-dimensional MetaCube objects, you can define queries to retrieve information from those tables. A query definition refers to the measures, dimension elements, attributes, and filters defined by previous objects of the same name.

Query definitions that include a measure retrieve transaction-based data, whereas queries that include only attributes or dimension elements from a given dimension retrieve data about the relationships within the dimensional hierarchy. Transaction-based queries must include at least one attribute or dimension element by which to group transactions. Such queries may in fact feature an unlimited number of attributes or dimension elements from an unlimited number of dimensions.

Table 1-2 on page 1-13 summarizes each component of a query's definition. Each query belongs to a collection descended from a particular instantiation of a Metabase object and is defined in terms of the multi-dimensional view inscribed by a DSS System.

Instantiating a Query Object

To instantiate a Query object, simply add a new instance of the Query class of objects to a Metabase object's collection of queries:

```
    MyMetabase.Queries.Add “A Brand-New Query”
```

When instantiating a query you must include the name of the query as an argument. When Explorer instantiates a new query, the application generates a generic, sequentially numbered name such as "Untitled1."

Query Properties

The Query class of objects actually represents a collection of attributes, measures, filters, and multi-dimensional results. As such, this master object's properties and methods allow you to generally characterize and manipulate collections of attributes, measures, filters, and results as a single entity that defines the data you want to retrieve from a database and how you want to summarize, pivot, and present that data.

The data a Query object retrieves is thus defined by the objects within its various collections, whereas its properties reflect characteristics such as the performance cost of processing the query, the name of the query and its author, the availability of the query's result, and its definition in the metadata tables. Table 8-1 summarizes the properties of the Query class of objects.

Table 8-1 *Query Class of Objects: Properties*

Properties	**Description/Example**
Accuracy	Long: A number between 1 and 100 indicating the degree of accuracy with which MetaCube should attempt to process a query. Any value less than 100 prompts MetaCube to process the query against a sample table. The range of accuracy requested for the query directs MetaCube to extrapolate a result from a larger or smaller sample table, as available, but the accuracy value itself bears no absolute statistical relevance. Defaults to 100. **MyQuery.Accuracy = 60** For more information about sampling, accuracy, and margins of error, as well as a complete example, see "The Sample Class of Objects" on page 6-28.
Author	String: Identifies the author of a query; defaults to the name of the database user provided at login. **MyQuery.Author = "informix"**

Table 8-1 *Query Class of Objects: Properties (continued)*

Properties	**Description/Example**
Confidence	Long: A number between 1 and 100 determining the statistical confidence with which MetaCube will report results extrapolated from sample tables. As the value of this property increases, the range of error values also increases. For example, MetaCube may be able to predict with 80 percent confidence that a number falls between 210 and 230, but can only predict with 50 percent confidence that the number falls between 215 and 225. Defaults to 100. The CellError property and the FetchCellError, ErrorVBArray, and ErrorSpreadClip methods of the MetaCube object class return the margin error for a sampled report. See "The Sample Class of Objects" on page 6-28 for a more detailed explanation of sampling and extrapolated query results. **MyQuery.Confidence = 50**
Cost	Long Integer: The relative performance cost of executing this query, as returned by MetaCube's optimizer for any valid transactional query before or after execution. This value reflects the size of the aggregate table, fact table, or sample table chosen by the MetaCube engine to answer the query. Although this value generally corresponds to the number of rows in the table, its scale ultimately depends on how the metadata for those tables has been defined. Costs are additive; the cost of queries consisting of multiple SQL statements or SQL statements accessing multiple fact / aggregate tables is the sum of the costs of the tables accessed. Read-only. **If MyQuery.Cost > 1000 _** **Then MsgBox "Query may involve delay."**
CurrentData	Boolean. A true value indicates that MetaCube has executed the query as currently defined and the result remains resident in local memory; a false value indicates otherwise. Read-only. **If MyQuery.CurrentData = True _** **Then MsgBox "Query result in memory."**

Table 8-1 *Query Class of Objects: Properties (continued)*

Properties	**Description/Example**
DataSource	String: Stores the name of the data source for which a query is currently being defined. Please note that this property only stores information to which an application may refer after opening a saved query, thereby determining which dimensions and measures to display. MetaCube neither assigns a default value to this property nor uses this information in any way when generating SQL for a query. Properly scoped, each QueryCategory and QueryItem identify the data source from which an attribute or measure is drawn; see "Scoping Rules" on page 14-3. Similarly, you can determine the dimensions, dimension elements, and attributes available for each data source by referring to the collection of Dimension objects owned by a particular FactTable object, as documented in "The Dimension Class of Objects, as Owned by a FactTable Object" on page 6-21. **Let MyQuery.DataSource = "Sales Transactions"**
ExecutionTime	Date variant: Indicates the length of time required to execute the query, incremented from 12:00:00 a.m. Null pending execution. Read-only. **MsgBox MyQuery.ExecutionTime**
Folder	Object, read-only: Represents the Folder object under which the Query object has been saved. This property is invalid for Query objects that have not been saved. **MsgBox MyQuery.Folder.Name**
Item-Orientation	This long constant determines whether the data returned by the Query object is organized by rows or columns. Table 8-6 on page 8-22 lists the appropriate constants. **MyQuery.ItemOrientation = OrientationColumn**
LastUpdate	Date variant: Indicates date and time of query's most recent change. Read-only. **MsgBox MyQuery.LastUpdate**
Live	Boolean: Indicates whether a connection has been established to execute the query as currently defined. Defaults to True, requiring a Metabase connection. This property stores a False value in cases in which the query has been defined off-line. Read-only. **MsgBox MyQuery.Live**

Table 8-1 *Query Class of Objects: Properties (continued)*

Properties	Description/Example
Maximum-Exceeded	Boolean: Indicates whether the query, upon execution, returned a number of rows exceeding the maximum allowed by the Metabase object's MaxTotalFetches property. Defaults to false. **If MyQuery.MaximumExceeded = True _** **Then MsgBox "Too many rows..."**
Name	String: The query object's name, which is specified as an argument upon instantiation. Default property. **MyQuery.Name = "Untitled1"**
Parameters	Stores as a read-only ValueList all filter parameters undefined for the query. Parameters previously defined by Agent Administrator, the application, or the user will not be included in this list. To review an application that deploys parameters, see MetaCube API Exercise 20 on page 8-13. **MsgBox = MyQuery.Parameters**
Parent	Object: The Metabase object. **MsgBox MyQuery.Parent.Name**
Saved	Boolean: True indicates that the query as currently defined is saved in the database; false indicates otherwise. **If MyQuery.Saved = False Then MyQuery.Saved**
SQL	ValueList: Stores the SQL generated by the MetaCube engine for any valid query, with each SQL statement representing a separate string in an array of values. For each entity included in the COMPARE expression of a QueryCategory and for each different data source included in a query, MetaCube generates a separate SQL statement, as documented in "Compare" on page 5-42. See also MetaCube API Exercise 2 on page 2-7. **MsgBox MyQuery.SQL**
TimeFiltered	Boolean. True indicates that the query includes a filter on time; false indicates otherwise. Read only. **MsgBox MyQuery.TimeFiltered**

Query Methods

Table 8-2 summarizes the Query object's methods.

Table 8-2 *Query Class of Objects: Methods*

Method	Description/Example
AsynchLast-Error	Returns a string containing the exception message generated when an aynchronous query fails. An asynchronous query is generated by the AsynchRetrieve method. **MsgBox MyQuery.AsynchLastError**
Asynch-Retrieve	This method explicitly commands MetaCube to transmit the SQL generated for a query directly to the relational database and to do so in a separate thread so the query executes asynchronously, freeing the user from waiting for the query's results. Except for initiating asynchronous execution, this method otherwise behaves exactly like Query.Retrieve. If a user is limited to mandatory QueryBack jobs, the same limitations will apply when that user attempts to submit an asynchronous query. **Note:** Only one asynchronous query per Query object can run at any given time. While an asynchronous query is running, no method can change the definition or execution of a Query object. **MyQuery.AsynchRetrieve**
Asynch-RetrieveStatus	This method returns a string showing the status of an asynchronous query (a query transmitted to the relational database using Query.AsynchRetrieve). If the asynchronous query is retrieving rows, this method will return a row count. If there is no asynchronous query outstanding or an asynchronous query fails, the returned string is empty. To retrieve a string containing the last exception message generated when an asynchronous query fails, use the AsynchLastError method. **MsgBox MyQuery.AsynchRetrieveStatus**
CancelAsynch Retrieve	This method cancels an asynchronous query. Because only one asynchronous query can execute at any given time, no arguments are necessary for this method. This method will not complete until the asynchronous query has stopped executing. **MyQuery.CancelAsynchRetrieve**

Table 8-2 *Query Class of Objects: Methods (continued)*

Method	Description/Example
Clear-Parameters	This method erases any values a procedure previously assigned to the parameters included in a query. This method does not enable the application to bypass or erase parameter values created in Agent Administrator. Those values always override parameters assigned by the application. **MyQuery.ClearParameters**
GetParameter-Object	This method returns the QueryCategory included in the filter definition for a specified parameter. Since the QueryCategory object's default property, Category, stores a self-descriptive string, this method is useful for identifying the attribute for which values must be supplied to complete the filter. To review an application that invokes this method, see MetaCube API Exercise 20 on page 8-13. The method requires one argument, an index number identifying the parameter for which the Query-Category object is sought. **MyQuery.GetParameterObject 1**
GetParameter-Operator	This method returns a string containing the operator for an undefined parameter. Since more than one parameter may be undefined for a given query, you must identify the undefined parameter by index number. This method is useful for precluding users from submitting multiple values for a parameter using an "=" operator. **MsgBox MyQuery.GetParameterOperator (0)**
OpenStorage	This method returns a Query object, along with all children and any data stored as a query result, from an IStorage object. An IStorage object can store information in almost any location, including a local file. This method is available only in C++ and other development environments that directly support the COM interface. The method accepts one argument, an IStorage object, which you can initialize according to your custom storage needs. Once the object has been initialized, the query can be saved in an IStorage object using the SaveStorage method of the Query class of objects.

Table 8-2 *Query Class of Objects: Methods (continued)*

Method	Description/Example
Retrieve	This method explicitly commands MetaCube to transmit the SQL generated for the query directly to the relational database. Before execution, the query must either consist of one QueryItem and one QueryCategory, or one or more QueryCategory objects specifying an attribute from the same dimension. Several methods of the MetaCube class of objects, including ToVBArray and ToSpreadClip, can implicitly require query execution, rendering deployment of this method unnecessary. **MyQuery.Retrieve**
Save	This method saves the query's definition in metadata tables on the relational database under the name and author specified by the Query object's corresponding properties. Consequently, no arguments are required. **MyQuery.Save**
SaveAs	This method saves the query's definition in metadata tables on the relational database under a different name than that specified by the Query object's Name property. This method requires you to specify the query's name as a string and the folder under which the query definition will be saved as an object. Two queries with the same name cannot be saved to a single folder. For a complete example of saving and opening queries and filters into and from different folders see MetaCube API Exercise 19 on page 7-7. **MyQuery.SaveAs "Sales Report", MyMetabase.RootFolder**
SaveStorage	Saves a Query object as an IStorage object, including all the children of that query as well as any data associated with the query. An IStorage object can store information in almost any location, including a local file. This method is available only in C++ and other development environments that directly support the COM interface. The method accepts one argument, an IStorage object, which you can initialize according to your custom storage needs.

Table 8-2 *Query Class of Objects: Methods (continued)*

Method	Description/Example
SetParameter	This method assigns a value or values to a filter parameter. The method requires two arguments: the index number of the parameter, which will depend on the order in which the Filter-Element object has been instantiated, and the values to be substituted for that parameter, listed in a single string. The string should conform to SQL standards, listing values in parentheses, with each value in single quotes demarcated by a comma, as shown. **MyQuery.SetParameter 0, "('Alden', 'Delmore')"** For a complete example, see MetaCube API Exercise 20 on page 8-13. Please note that when submitting parameterized queries to QueryBack, undefined parameters must be stored in the metadata for future reference by the UNIX process clientexec. To identify and define parameters in MetaCube's metadata, launch Agent Administrator. Parameters defined through Agent Administrator and registered in MetaCube's metadata take precedence over any parameter assignments made by the SetParameter method.
SetSQL	This method replaces an SQL statement generated by MetaCube's analytical engine with a string specified as an argument. As COMPARE expressions or multi-fact table queries may result in multiple SQL statements for a given query, you must identify the SQL statement to be replaced by index number, with the first statement identified by a zero. The method thus requires two arguments, the index number, an integer, and the replacement SQL statement, a string. **MyQuery.SetSQL 0, "SELECT…"**

Table 8-2 *Query Class of Objects: Methods (continued)*

Method	**Description/Example**
Submit	This method submits the query to MetaCube's QueryBack agent for background processing, instantiating a QueryBackJob object. Please note that you cannot submit a query for background processing if any of the filters included in that query have not been saved. The Submit method requires four arguments: a string identifying the name of the QueryBack job; a numeric integer indicating the query's priority, as compared to other queries that may be queued for background processing; the time at which you would like the server to process the query; and a numeric argument indicating the frequency with which the query should be re-executed, if ever. To assign a high priority to a query, specify a high number as a priority argument. Explorer limits users to a priority of five, but MetaCube does not. Table 8-3 on page 8-18, explains the significance of each frequency argument. The arguments for this method are arranged in the format: **Set MyQueryBackJob = Query.Submit Name (string), _** **Priority (integer), TargetStartTime (date variant), _** **RecurType (integer)** For an example of this method see MetaCube API Exercise 21 on page 8-15. For a discussion of how to track and retrieve Query-BackJob results, see "The QueryBackJob Class of Objects" on page 8-71.

The following two exercises describe particularly complex procedures for submitting queries to the database. The first example, MetaCube API Exercise 20, demonstrates how to define a query that includes a parameterized filter. The second example, MetaCube API Exercise 21 on page 8-15 demonstrates how to submit a query to QueryBack.

MetaCube API Exercise 20: Executing Queries That Include Parameterized Filters

```
Sub Parameters()

'Declare Variables
    Dim MyMetabase As Object, MyQuery As Object, _
        MyFilter As Object, MyMetacube As Object, _
        MyData As Variant, Count As Integer, _
        Parameters As Variant, _
        ParameterValues As Variant

'Connect
    Set MyMetabase = CreateObject("Metabase")
    MyMetabase.Connect

'Define Query
    Set MyQuery = MyMetabase.Queries.Add("My New Query")
    MyQuery.QueryCategories.Add "Brand"
    MyQuery.QueryItems.Add "Units Sold"

'Define Parameterized Filters
    MyQuery.ClearParameters
    Set MyFilter = MyQuery.Filters.AddNewFilter _
        ("Brand & Region Parameters")

    MyFilter.FilterElements.Add "Brand", "In", _
      "<<Please enter brands to filter on...>>"

    MyFilter.FilterElements.Add "Region", "In", _
      "<<Please enter regions to filter on...>>"

    MsgBox MyQuery.Parameters   'All undefined parameters
    Let Parameters = MyQuery.Parameters.ArrayValues
      'Stores both parameters as array

    For Count = 0 To UBound(Parameters) 'to # of param.
     Let ParameterValues = InputBox _
       (Title:=MyQuery.GetParameterObject(Count), _
       Prompt:=Parameters(Count))
     MyQuery.SetParameter Count, ParameterValues
    Next Count  'Go back and do the next parameter

    MsgBox MyQuery.Parameters
    'All parameters defined, nothing to show
```

```
34 'Get Results
35     Worksheets.Item("Query Report").Activate
36     Set MyMetacube = MyQuery.MetaCubes.Add("Data")
37     Let MyData = MyMetacube.ToVBArray
38     Set ReportRange = ActiveSheet.Range _
39         (ActiveSheet.Cells(1, 1),
40         ActiveSheet.Cells _
41         (MyMetacube.Rows, MyMetacube.Columns))
42     Let ReportRange.Value = MyData
43     ReportRange.EntireColumn.AutoFit

44 End Sub
```

Explanation of MetaCube API Exercise 20

This procedure defines a filter consisting of two constraints, each represented by a different FilterElement object. The syntax for instantiating those objects includes three arguments: the name of the attribute from which values are being selected; the operator; and the values themselves, also called the operand. In this example, however, parameters appear in place of the operand, enabling the user to specify different attribute values for the filter at run-time. A parameter, which can be any string, appears bracketed in a pair of less-than and greater-than symbols on lines 20 and 22.

The Parameters property of the Query object stores a list of undefined parameters, comprised of parameters for which values must be specified prior to execution of the query. Once a value has been substituted for a parameter, that parameter is no longer included in the list. The Message Box created on line 23 thus includes two parameters, whereas the Message Box created on line 32 displays none, indicating that attribute values have been substituted for every parameter.

Because the Parameter property of the Query object stores the entirety of every parameter label included in the ValueList, we can store those parameters in an array, as represented by the variant variable Parameters, subsequently displaying each parameter label as a prompt in a dialog. Lines 26 to 31 iterate through the parameters in the array, displaying in a dialog the parameter label as a prompt. The title-bar of the dialog displays the name of the attribute for which parameter values are sought, obtained by the GetParameterObject method on line 28.

The SetParameter method substitutes the entered value for the parameter. This method requires two arguments:

- the index number of the parameter, in this case identified by the loop counter
- the SQL syntax for a list of attribute values, as a string variable called ParameterValues. Acceptable syntax is of the form "('Value1', 'Value2',...)"

When generating SQL for a query, MetaCube only retrieves data for the specified attribute values.

As noted previously, parameters set by an application remain set only as long as the application maintains a connection to MetaCube. Parameters defined by an application no longer apply to QueryBack jobs, which require all parameters to be saved in the metadata through MetaCube's Agent Administrator application. There is no programmatic interface for defining QueryBack parameters.

The following exercise illustrates how to submit a query to QueryBack. Please note that you must create a configuration for connecting to a server-side database running MetaCube Agents to execute this procedure.

MetaCube API Exercise 21: Submitting a Query to QueryBack

```
Option Explicit
Sub Submit_QueryBack_Query_Immediately()
'Declare Variables
Dim MyMetabase As Object, _
MyQuery As Object, _
MyMetaCube As Object, _
MyQueryBackJob As Object, _
QBQuery As Object, _
QBCube As Object, _
ReportRange As Range, _
MyData As Variant
'Declare Constants
Const Priority = 4
Const RecurTypeNone = 1
Const QueryBackJobStatusPending = 0
Const QueryBackJobStatusFinished = 2
```

```
'Connect
Set MyMetabase = CreateObject("Metabase")
MyMetabase.Connect

'Build Query
Set MyQuery = MyMetabase.Queries.Add("New Query")
MyQuery.QueryItems.Add "Units Sold"
MyQuery.QueryCategories.Add "Brand"

'Add cube to MyQuery's cube collection
Set MyMetaCube = MyQuery.MetaCubes.Add("New Cube")
Let MyMetaCube.Scratch = False

'Submit to QueryBack
Set MyQueryBackJob = MyQuery.Submit _
(MyQuery.Name, Priority, MyMetabase.CurrentTime, _
               RecurTypeNone)
'Query scheduled to run on the server, as soon as possible

'Wait for Query to Finish
Check:
MyQueryBackJob.RefreshStatus
MsgBox Prompt:=MyQueryBackJob.Status, Title:="Job Status"
MsgBox "Check the status of the QueryBack job now?"
If MyQueryBackJob.Status <> _
       QueryBackJobStatusFinished Then GoTo Check

'Get QueryBackJob, Store Query in QBQuery
Set QBQuery = MyQueryBackJob.Retrieve

'Cube and Query returned by QueryBack
MsgBox QBQuery.MetaCubes.Count
Set QBCube = QBQuery.MetaCubes.Item(0)

'Format data as an array VB can display, store in variable
Let MyData = QBCube.ToVBArray

'Clear "Query Report" Worksheet
Sheets("Query Report").Activate
Cells.Select
Selection.ClearContents

‘Excel Code:  Defines Range of Cells, Presents Data
Worksheets.Item("Query Report").Activate
Set ReportRange = _
    ActiveSheet.Range (ActiveSheet.Cells(1, 1), _
    ActiveSheet.Cells (QBCube.Rows, QBCube.Columns))
Let ReportRange.Value = MyData
ReportRange.EntireColumn.AutoFit  'Sizes columns

End Sub
```

Explanation of MetaCube API Exercise 21

This exercise instantiates a Query object as MyQuery and defines it by one measure and one attribute, *Units Sold* and *Brand*, respectively.

Lines 21 to 23 define the query, storing an instance of the Query object in the object variable in MyQuery. Lines 25 and 26 also instantiate a MetaCube object and set its scratch property to false, enabling MetaCube to store all cubes associated with a query when the query is saved or submitted to QueryBack.

On line 28, we submit the job for background query processing, using the Submit method of the Query object to instantiate a new QueryBackJob object. To instantiate the QueryBackJob object, we must specify the name of the job, the job's priority, the time at which the job should run, and how often the job should recur.

The name of the QueryBackJob is, in this case, specified using the Name property of MyQuery, although QueryBackJob names can differ from Query names. The query has a priority of 4 and is set not to recur. The CurrentTime property of the Metabase object returns the time from the PC clock, instructing the QueryBack agent to process the query as soon as possible.

Once the query has been submitted, we must periodically review the job queue to determine its status. Lines 33 to 38 define a loop that recurs until the job finishes, using the RefreshStatus method of the QueryBackJob object to poll the queue.

Line 40 executes once the status of the QueryBackJob indicates that the job has finished. The Retrieve method returns a new Query object, storing the new object in a new variable, QBQuery. Line 42 displays a MessageBox confirming that the new Query object returned by the Retrieve method also includes a MetaCube object. Line 45 stores this object in the QBCube object variable. New object variables are declared for both Query and MetaCube objects to demonstrate that neither object was merely resident in memory and that the Retrieve method returned genuinely new Query and MetaCube objects. The rest of the query is displayed in a spreadsheet as before.

For more information about QueryBack jobs, see “The QueryBackJob Class of Objects” on page 8-71.

Related Constants

Table 8-3 summarizes the numeric values for the Submit method's frequency argument.

Table 8-3 *QueryBack Frequency Constants*

Frequency	MetaCons.bas Constant Name	Constant
Once	RecurTypeNone	1
Daily	RecurTypeDaily	2
Weekly	RecurTypeWeekly	3
Monthly	RecurTypeMonthly	4
Annually	RecurTypeAnnually	5

Query Collections

The Query object's collections define the components of a query, as depicted in Figure 1-1 on page 1-9. Of the four collections, three incorporate references to MetaCube's metadata, with QueryCategory objects identifying the attributes by which a query groups or summarizes transactional data, QueryItem objects identifying the measures a query retrieves, and Filter objects identifying the set of constraints to place on the range of data a query retrieves. MetaCube objects represent ways of organizing, summarizing, and presenting the data a query retrieves.

Table 8-4 summarizes the collections of a Query object.

Table 8-4 *Query Class of Objects: Collections*

Collections	**Description/Example**
DrillData-Sources	Consists of the FactTable objects that can be accessed by a query. A query can access information in different fact tables only if the data in those fact tables can be grouped by the attributes currently included in the query. As different QueryCategory objects incorporate attributes into a query definition, the MetaCube analysis engine excludes FactTables objects from the DrillDataSources collection on the basis of the Dimension objects contained in each FactTable's DimensionMappings collection. Applications cannot directly instantiate a new item in this collection, and no add method is available. This collection is thus available only for reference. For an overview of the properties of a given FactTable object within this collection, see Table 6-1 on page 6-4. **MsgBox MyQuery.DrillDataSources.Item (0).Name**
Filters	Consists of ad hoc or saved filters that have been applied to the query's definition. Any ad hoc filters designed for a particular query exist only within this collection until saved. **MyQuery.Filters.Add "This Week"**
MetaCubes	Consists of different multi-dimensional representations of a query result, often referred to as virtual cubes of data. MetaCube does not, however, store data in a physical cube. **MyQuery.MetaCubes.Add "Break Report"**
Query-Categories	Consists of objects that identify the names of Attribute and/or DimensionElement objects by which the query groups and summarizes transactional data in the report. **MyQuery.QueryCategories.Add "Brand"**
QueryItems	Consists of objects that specify the type of numeric data the query retrieves; refer to the names of Measure objects. **MyQuery.QueryItems.Add "Units Sold"**

The QueryCategory Class of Objects

A QueryCategory object specifies an attribute or expression to include in a query's definition. Attribute objects, discussed in "The Attribute Class of Objects" on page 4-13, describe physical columns in the relational database storing string values by which transactional data is characterized and grouped. Organized in dimensions, attributes typically describe different levels within a hierarchy of increasingly summarized values. From the collection of available attributes owned by the Metabase object or from the collections of available attributes owned by the Dimension objects associated with a fact table, a QueryCategory identifies an Attribute object to apply to a query. A QueryCategory object can also represent some function performed on an Attribute object, such as a Bucket or a Comparison function.

To include an attribute in a query's definition, simply instantiate a QueryCategory object, identifying by name the Attribute object defined as a component of the Metabase object's metadata:

```
MyQuery.QueryCategories.Add "Brand"
```

The case-sensitive attribute name is stored as a string in the QueryCategory object's only unique property, the **Category** property. Although Explorer does not allow users to incorporate dimension elements into their queries, you can also specify a DimensionElement object when instantiating a QueryCategory. To specify a Comparison or Bucket expression as a QueryCategory, see "Extension Functions as QueryCategory Expressions" on page 5-40.

Table 8-5 *QueryCategory Class of Objects: Properties*

Properties	Description/Example
Category	This property stores a string value representing the name of the attribute or the syntax of the expression that defines groupings within a query. Assigning a new value to this property alters the grouping of the query originally specified when the QueryCategory is instantiated. This property is the default property of the QueryCategory class of objects. **MsgBox MyQueryCategory.Category**

Table 8-5 *QueryCategory Class of Objects: Properties (continued)*

Properties	**Description/Example**
Name	This property stores a label identifying the QueryCategory. Changing the value of this property leaves the grouping of the query unaltered but changes the label MetaCube returns when displaying QueryCategory values. Note that this property is unlike the Bucket function, which groups and labels values of the QueryCategory rather than the QueryCategory itself. Until a new label has been assigned to the QueryCategory, this property stores the same string value as the Category property. **Let MyQueryCategory.Name = "NewName"**
Object	This read-only property points to the Attribute object on which a QueryCategory expression is based. The QueryCategory object often represents an attribute object, and in such cases this property points to an object similar to the QueryCategory itself. But when a QueryCategory object represents a bucket or some other expression, the Object property points to the Attribute object to which the syntax of that bucket expression refers. The Object property of a QueryCategory representing buckets on the Brand attribute would, for example, point to the Attribute object for Brand. Please note that this property stores a null value for expressions based on multiple Attribute objects, such as a comparison. **MsgBox MyQueryCategory.Object.Name**
Orientation	This long constant determines whether each of the values returned by the QueryCategory object will be displayed in separate rows, columns, or pages. By default, MetaCube displays such values in the row orientation. Changing the value of this property after a report has been generated ultimately involves instantiating a new MetaCube object but does not require the analysis engine to re-query the database. Table 8-6 on page 8-22 lists the appropriate constants. **MyQueryCategory.Orientation = OrientationColumn**
Parent	Stores the Query object to which the QueryCategory object belongs. **MyQueryCategory.Parent.Name**

Table 8-5 *QueryCategory Class of Objects: Properties (continued)*

Properties	**Description/Example**
SortDirection	This long constant determines whether values of an attribute will be sorted in ascending (alphabetic) or descending (reverse-alphabetic) order. Changing the value of this property after a report has been generated ultimately involves instantiating a new MetaCube object but does not require the analysis engine to re-query the database. See Table 8-6 on page 8-22 for a listing of numeric arguments and their corresponding constants. The SortRow and SortColumn properties of the MetaCube object class, which sort columns or rows on the basis of a measure's values, over-ride conflicting sorts applied by this property. See MetaCube API Exercise 23 on page 8-49. Defaults to ascending order. **MyQueryCategory.SortDirection = SortDirectionDesc**

Table 8-6 summarizes the constants for the QueryCategory object's Orientation property.

Table 8-6 *Constants for the QueryCategory Object Class's Orientation Property*

Orientation	**MetaCons.bas Constant Name**	**Constant**
Rows	OrientationRow	1
Columns	OrientationColumn	2
Pages	OrientationPage	3

The SortDirection Property

Sorts allow you to arrange values within an attribute in alphabetic or reverse-alphabetic order and to arrange values of a measure in descending or ascending order of magnitude. For a more detailed explanation of sorts, consult the *MetaCube Explorer User's Guide*.

By default, all attribute values are sorted in ascending, or alphabetic order, whereas measures are not sorted at all. To sort measures, assign a value to the SortColumn or SortRow properties of the MetaCube class of objects, identifying the column or row of numeric data on which you want to perform the sort. See Table 8-17 on page 8-43.

Table 8-7 summarizes the numeric values for the SortDirection property.

Table 8-7 *Numeric Constants for the SortDirection Property*

Sort Direction	MetaCons.bas Constant Name	Constant
No Sort	SortDirectionIgnore	0
Ascending Order	SortDirectionAsc	1
Descending Order	SortDirectionDesc	2

The QueryItem Class of Objects

Just as the QueryCategory object identifies an attribute to apply to a query, the QueryItem object identifies a measure to apply to a query.

To include a measure in a query's definition, simply instantiate a QueryItem object, identifying in the Add method's argument the precise name of the Measure object:

```
MyQuery.QueryItems.Add "Units Sold"
```

Because you can perform calculations on and apply formats to a measure, the QueryItem object's properties are slightly more extensive than the properties for a QueryCategory object.

The QueryItem object class has several properties, summarized in Table 8-8.

Table 8-8 *QueryItem Class of Objects: Properties*

Properties	Description/Example
FormatString	This property stores as a string syntax for formatting numeric data in the application or control responsible for displaying query results. See "The FormatString and FormatStrings Properties: An Overview" on page 8-25. **MyQueryItem.FormatString = "#,##0.00"**

Table 8-8 *QueryItem Class of Objects: Properties (continued)*

Properties	**Description/Example**
Item	This property stores a string value representing the name of the measure or the syntax of the expression that defines a QueryItem. Assigning a new value to this property alters the numeric data retrieved by the query originally specified when the QueryItem is instantiated. This property is the default property of the QueryItem class of objects. **MsgBox MyQueryItem.Item**
Name	This property stores a label identifying the QueryItem in a report. Changing the value of this property leaves the numeric data of the query unaltered but changes the label MetaCube returns when displaying the name of the QueryItem. Until a new label has been assigned to the QueryItem, this property stores the same string value as the Item property. **Let MyQueryItem.Name = “NewName”**
Object	This read-only property stores the Measure object on which a QueryItem expression is based. The QueryItem object often itself represents a Measure object, and in such cases, this property stores an object similar to the QueryItem. But when a QueryItem object represents an expression such as MovingAvg or TopN, the Object property stores the Measure object to which the syntax of the expression refers. Please note that this property would store a null value for expressions based on multiple Measure objects, although no such expressions currently exist. **MsgBox MyQueryItem.Object.Name**
Parent	Object: Returns the Query object to which the collection of QueryItems belongs. **MsgBox MyQueryItem.Parent.Name**

The QueryItem object class features no methods, and owns no collections.

The FormatString and FormatStrings Properties: An Overview

Properties of MetaCube, QueryItem, and Measure object classes are responsible for storing the syntax for formatting numeric data in different display environments, such as an Excel Spreadsheet or a reporting control. The FormatStrings property of the MetaCube object class is documented in Table 8-17 on page 8-43, and the FormatString property of the Measure object is documented in Table 6-8 on page 6-23.

Both the FormatString property of the QueryItem object and the same property of the Measure object define the syntax for a measure's formatting, which the MetaCube engine can store but not interpret or process. An object control or the application itself, and not MetaCube, ultimately formats the data, interpreting the formatting syntax stored by MetaCube in MetaCube's metadata or, in the case of a QueryItem, in memory. The syntax of the string will thus vary, depending on the formatting information required by the object control or by the application to format numeric data.

Although the FormatString property of the QueryItem object class defines the formatting of a measure as it will be displayed for a particular query, the same property of the Measure object class assigns a default format to the measure for all queries. The property of the QueryItem object class can be assigned prior to running a query, overriding the property of the Measure object class, set when defining MetaCube's metadata.

The FormatString properties of the QueryItem and Measure object classes enable you to define formatting syntax, but the FormatStrings property of the MetaCube object class returns such syntax in a read-only ValueList, providing a single, convenient source on which the reporting application or control can rely for all formatting syntax.

For any given query, the MetaCube object's FormatStrings property stores the format for each of the measures included in that query, regardless of whether that format was assigned when defining a query or defaults from metadata specifications. The formatting commands are repeated in the ValueList for each column or row of a given measure appearing in the report, alternating if necessary with any other measures that may also be included in the report. An array of formatting syntax organized in the same order as the columns of numeric data in the report enables you to easily apply different formats to different measures, even in a report with many columns or rows of numeric data, as shown in MetaCube API Exercise 22.

You should thus use:

- the FormatString property of the Measure object class when defining default formats for a measure in MetaCube's metadata
- the same property of the QueryItem object class when specifying a different format for the purposes of a single query
- the FormatStrings property of the MetaCube object to determine the formats that have ultimately been assigned to all measures included in a query

The syntax included in the example is Excel-compliant, as is the syntax displayed in MetaCube Explorer. The pound sign # indicates the places where a digit may be displayed, a zero 0 indicates places where a zero will appear if a digit does not exist. Commas typically demarcate every three decimal places, and periods indicate the position of the decimal point. For more information consult Microsoft Excel documentation or review the syntax appearing in the Format Cells dialog, which can be opened by choosing **Cells** from the **Format** menu whenever a worksheet is active.

MetaCube API Exercise 22 incorporates the FormatString and FormatStrings properties of all three object classes to enable users to review a measure's default formatting, as defined in MetaCube's metadata, and to suggest a new format. The query includes an attribute as well as two measures organized by columns, demonstrating the usefulness of the MetaCube object class's FormatStrings property in relatively complex queries.

MetaCube API Exercise 22: Formatting Measures

```
Sub Formatting_Measures()
'Declare Variables
    Dim MyMetabase As Object, MyQuery As Object, _
        MyFilter As Object, MyMetacube As Object, _
        MyData As Variant, ExcelFormat As String, _
        FormatArray As Variant, Count As Integer
    Const OrientationColumn = 2
'Connect
    Set MyMetabase = CreateObject("Metabase")
    MyMetabase.Connect
```

```
'Define Query
    Set MyQuery = _
        MyMetabase.Queries.Add("My New Query")
    MyQuery.QueryCategories.Add "Region"
    MyQuery.QueryCategories.Item("Region") _
        .Orientation = OrientationColumn 'More columns
    MyQuery.QueryCategories.Add "Brand"
    MyQuery.QueryItems.Add "Net Profit" 'New format
     MyQuery.QueryItems.Add "Units Sold" 'Default format
'Prompt for new format of Net Profit measure...
    Let ExcelFormat = InputBox _
    (Title:="Format Measure Dialog", _
     Prompt:= _
      "Profits currently displayed in " _
      + MyMetabase.FactTables.Item _
      ("Sales Transactions").Measures.Item _
      ("Net Profit").FormatString + _
      " format.  Enter a new format for profits:")
    Let MyQuery.QueryItems.Item _
      ("Net Profit").FormatString = ExcelFormat
'Get Results
    Worksheets.Item("Query Report").Activate
    Set MyMetacube = MyQuery.MetaCubes.Add("Data")
    Let MyData = MyMetacube.ToVBArray
    Set ReportRange = ActiveSheet.Range _
        (ActiveSheet.Cells(1, 1), _
        ActiveSheet.Cells _
        (MyMetacube.Rows, MyMetacube.Columns))
    Let ReportRange.Value = MyData
    ReportRange.EntireColumn.AutoFit  'Size columns
'FormatData
    Let FormatArray = _
      MyMetacube.FormatStrings.ArrayValues 'Get formats
    'There's an array value for each measure-column; cycle through…
    For Count = 1 To UBound(FormatArray)
        Columns(Count + 1).Select
        Selection.NumberFormat = FormatArray(Count)
    Next Count
End Sub
```

Explanation of MetaCube API Exercise 22

This procedure defines the familiar *Brand-Region* query, pivoting the *Region* attribute to the column orientation, so that the two measures included in the query, *Net Profit* and *Units Sold* appear twice, once for each region. Depending on the orientation of measures, the FormatStrings property of the MetaCube object returns an array listing the appropriate formatting for each column or row in the report, in the order in which the different measures are displayed in the report.

After defining a simple query, the procedure prompts the user to enter a new format for the Net Profit measure on lines 20 to 30. Embedded in the prompt at lines 25 to 27 is the default formatting syntax for the measure, as defined in MetaCube's metadata. The FormatString property of the Measure class of objects can be assigned new values when creating or editing metadata, or, as shown here.

To avoid an extremely long line of code, the user's input is stored in a variable, ExcelFormat, and subsequently assigned to the FormatString property of the QueryItem representing *Net Profit* in lines 29 and 30. Please note that because we assign a new value to the QueryItem's FormatString property rather than the Measure object's FormatString property, the new format applies only to the query including that QueryItem.

The query subsequently executes, returning the data into a spreadsheet named "Query Report." As usual, a spreadsheet of this name must exist before executing the procedure.

After the query has executed and the data returns to a range within a spreadsheet, one task remains for the MetaCube engine: to communicate the formatting for each measure to Excel, where the formatting is ultimately performed. The FormatArray variable stores an array of formatting syntax, with a separate string for each column of numeric data in the report, indicating how that column should be formatted. In this procedure, the syntax alternates between the new formatting for profits, and the default formatting for sales. MetaCube generates this array of alternating syntax, holding the array as a ValueList in MyMetaCube's FormatStrings property.

Since the FormatArray variable contains a separate value for each column in the report, we can deploy Visual Basic for Application's Ubound function to determine the number of values in the array, and thus the number of columns storing numeric data in the report, as shown on lines 42 and 43. Using a For… Next loop, the procedure iteratively formats each column. The loop counter, represented by the variable Count, serves two purposes:

- Identifying the column to format on line 42
- Locating a value within the array on line 43. This value contains the appropriate formatting syntax for the selected column.

The formatting begins with the second column of the report, which actually contains the first column of numeric data. For this reason, the Count variable is incremented by one when identifying the column to select.

Please note that the order of instantiation of different QueryCategory objects determines the order in which MetaCube groups values. If, for example, you instantiate a QueryCategory identifying the *Brand* attribute first and one identifying a *Region* attribute second, regions will be grouped by brand as long as those values are either both organized by column or both organized by row. You can re-arrange this configuration by deploying the MakeFirst method on an item within the QueryCategories collection.

The Filter Class of Objects

Filters limit the range of data retrieved by a query or incorporated into an aggregate table. To apply a filter to the data represented by a particular object, you must either include that filter in the collection of filters owned by that particular object or identify that filter through one of the object's properties, as the case may require.

The Collection's Methods

The Filter object collection features its own set of methods, summarized in Table 8-9.

Table 8-9 *Filters Collection: Methods*

Method	Description/Example
AddDefault	This method applies the default filter for a particular dimension to a query. You can deploy this method only when adding a Filter object to a collection owned by a query, and you must specify as an argument the name of the Dimension object for which you are applying a default filter. Each Dimension object features the DefaultFilter property, which identifies a particular Filter object as that dimension's default. **MyQuery.Filters.AddDefault "Time"**
AddNewFilter	Adds a new filter. You can deploy this method to create a new filter, either on an ad hoc basis for a particular query or to save that filter in MetaCube's metadata. To instantiate a new Filter object, you must specify its name as an argument to this method. Once you have created the filter, you can add FilterElement objects defining the criteria by which the filter limits data. **MyQuery.Filters.AddNewFilter "This Month"**
AddSaved	This method retrieves the definition of a filter stored in MetaCube's metadata tables from a library of filters associated with a particular folder and applies that filter to the Query object owning the Filters collection. Although Explorer prevents a user from deploying others' private filters, this security measure is artificially imposed by the application, not the programming interface. Through the programming interface, you can apply any filter in the DSS System to a query. The AddSaved method requires three arguments: the name of the saved filter; the name of the user who originally created the saved filter; and the folder, as an object, in which the filter is stored. To retrieve a public filter, specify the user name as "metapub." **MyQuery.Filters.AddSaved "This Month", "MetaDemo", _** **MyMetabase.RootFolder**

***Table 8-9** Filters Collection: Methods (continued)*

Method	Description/Example
CountGroup	This method returns as an integer the number of filters associated with a particular dimension or group. You must specify as an argument the name of the Dimension object by which filters are usually grouped. Filters may also be grouped by a fact table, in which case the group is named after the fact table (Explorer prefixes fact table groups with the syntax "FactTables"). If the filters were created in a custom application, they may be grouped using some other logic. **MsgBox MyQuery.Filters.CountGroup "Time"**
ItemGroup	This method retrieves a Filter object from the subset of filters associated with a particular dimension or group and identifies the object within that subset by an index number. This allows you to specify, for example, the second saved filter associated with the Time Dimension. You must specify the name of the Dimension object by which the filters are grouped and the index number of the particular item within that group. **Set MyFilter = MyQuery.Filters.ItemGroup("Time", 1)**
Remove	This method stops the application of a filter to a particular query without deleting the filter definition from the metadata. You must specify as an argument the index number of the filter within that group. **MyQueries.Filters.Remove 2**

Filter Properties

The Filter object's properties describe the general characteristics of a filter, such as its name, its owner, and the dimension with which it is associated. A Filter object collection of FilterElement objects defines the actual constraint or criterion by which the filter limits a range of data. Table 8-10 summarizes the general properties of the Filter object.

Table 8-10 *Filter Class of Objects: Properties*

Property	Description/Example
Enabled	Boolean: Setting the value of this property to false precludes MetaCube from applying the filter to the query result without excluding the filter from the collection of filters owned by the Query object. Defaults to true. **MyFilter.Enabled = False**
Folder	Object, read-only: Represents the Folder object under which the Filter object has been saved. This property is invalid for Filter objects that have not been saved. **MsgBox MyFilter.Folder.Name**
Group	String: Identifies the name of the Dimension object or Fact Table object by which the filter is grouped. You can also specify a new grouping, corresponding to either Dimension or Fact Table names, by which filters are grouped. Although the programming interface allows you to define a filter constraining values of measures, attributes and dimension elements from different dimensions or fact tables, this property associates each Filter object with a particular dimension or fact table. This association enables Explorer and other applications to organize filters by dimension or fact table for display in a user interface. **MyFilter.Group = "Time"**
Name	String: Identifies the Filter object. The default property. **MsgBox MyFilter.Name**
Owner	String: This read-only property identifies the name of the user who owns the filter. Defaults to the user name provided at login. **MsgBox MyFilter.Owner**
Parent	Object: Query object. **MsgBox MyFilter.Parent.Name**

Table 8-10 *Filter Class of Objects: Properties (continued)*

Property	Description/Example
Saved	Boolean: Indicates whether the definition of the filter changed since its most recent save. This read-only property returns false if the filter has changed, true otherwise. **MsgBox MyFilter.Saved**
Updatable	Boolean. Indicates whether the current user has privileges to edit the filter. In this release of MetaCube, this property always returns true. **MsgBox MyFilter.Updatable**

Filter Methods

The Filter object's methods save and delete Filter objects. In saving a Filter object, you store the definition of the filter in metadata tables on the relational database. In deleting a filter, you destroy the database records storing that filter's definition. Table 8-11 summarizes the Filter object's methods.

Table 8-11 *Filter Class of Objects: Methods*

Method	Description/Example
DeleteFilter	This method deletes the metadata storing a filter's definition in the relational database, regardless of whether the corresponding Filter object exists within a collection owned by a Query object or a Metabase object. When you delete a Filter object, MetaCube not only no longer recognizes the filter's existence, the definition of the filter no longer exists. This method requires no arguments. **MyFilter.DeleteFilter**
FullPathName	This method returns the full path to a Filter object, which may be necessary to identify a mandatory filter. Typically mandatory filters are assigned using MetaCube Secure Warehouse. You must specify as an argument the name of the Filter object for which a full path is needed. **UserFilterPath = MyFilter.FullPathName("UserFilter")**

Table 8-11 *Filter Class of Objects: Methods (continued)*

Method	Description/Example
Save	This method saves the definition of an existing filter in metadata tables on the relational database. The filter is saved under its previous name, folder, owner, and group. To change any of these values, deploy the RenameFilter method of the Folder object class. To create a copy of a Filter with a new name, folder, or group, deploy the SaveAs method of the Filter object class. Both methods are illustrated in MetaCube API Exercise 19 on page 7-7. **MyFilter.Save**
SaveAs	This method saves a new Filter object or saves an existing Filter object under a new name or in a different folder. Before saving the filter, the group to which the filter belongs must be specified by assigning a value to the Group property of the Filter object. For this method, the name of the filter is specified as a string argument, and the folder into which the definition should be stored as an object: **MyFilter.SaveAs "My Brands", MyMetabase.RootFolder** See MetaCube API Exercise 19 on page 7-7 for an example of an application involving this method.

The FilterElement Class of Objects

A filter consists of one or more criteria limiting the range of a data set in a report or an aggregate. The criteria defining a filter are represented as a collection of FilterElement objects owned by the corresponding Filter object. Just as filters can be applied to a query or to an aggregate, so a FilterElement object can be applied directly to a measure as a constraint. For an explanation of measure constraints, which preclude a calculated measure from performing operations like division by zero, see “The Measure Class of Objects” on page 6-21. For an introduction to aggregate filters, see Table 6-3 on page 6-9. We will concern ourselves chiefly with FilterElements as they limit the data returned by a query.

Each FilterElement object identifies values within a measure, attribute, or dimension element to include or exclude from a report. A criterion may, for example, include the “East” value of the *Region* attribute, such that a query can retrieve only transactions associated with that region. Please note that your query definition need not group transactions by the *Region* attribute to apply a filter on the *Region* attribute against that query.

In the previous example, we defined a constraint that chose all transactions for which the *Region* attribute equaled “East.” You can also define constraints incorporating more sophisticated operators, such as <, >,<>, <=, >=, like, in, and not null. For the numerical values of a measure or a dimension element these operators can perform functions like including only sales greater than $1,000, or stores with codes less than 800.

The less than and greater than operators can also apply alphabetically to the string values of an attribute, with a “less than” operator corresponding to earlier in an alphabetic list of values and a “greater than” operator corresponding to later in the alphabetic list of string values. The “In” operator enables you to include multiple, explicitly-identified values in a constraint, such as the “East” region and the “West” region. The “Like” operator includes all values containing a set of letters or digits, with the “%” symbol demarcating either end of the set. MetaCube also supports such operators as like, in, not null, etc.

Because MetaCube recognizes the date of the most recent transactions stored in the Data Warehouse, you can define dynamic, time-dependent filters, which include different values depending on which values in the Data Warehouse are most recent. For example, you can limit data to the most recent three weeks of transactions or to transactions for this month and the same month last year.

Rather than specifying a value of the attribute or dimension element on which you are filtering, you must specify one of the following dynamic parameters: Current Period, Last N Periods (where N can be any integer), Current Period and Same Period Last Year, or Same Period Last Year. The duration of the period corresponds to the type of time attribute or dimension element on which you are filtering, be it Day, Week, Month, Quarter, etc. When specifying a parameter, you must always enclose the parameter in brackets, so that MetaCube does not mistake the parameter for an actual value, such as “<<Current Period>>” or “<<Last 4 Periods>>.”

Although a properly configured MetaCube system can recognize such common relative-time parameters, you can also create new parameters, prompting users to enter the values to be substituted for these parameters immediately prior to execution of the query. Such parameters can be assigned any label, as long you bracket that label within less-than and greater-than operators. It is convenient to label the parameter such that it may subsequently be offered as a prompt in a dialog requesting the values of the parameter. See MetaCube API Exercise 20 on page 8-13.

Different properties of the FilterElement object identify each component of a constraint. Table 8-12 summarizes the properties of the FilterElement object.

Table 8-12 *FilterElement Class of Objects: Properties*

Property	**Description/Example**
FilterOn	String. Identifies the name of the attribute, dimension element, or measure from which the values are to be selected in the constraint. **MyFilterElement.FilterOn = "Week"**
FilterType	Long, read-only: Indicates whether the FilterElement is based on an attribute, measure, or dimension element object. For the correspondence between the numeric value stored by the property and the filter type, see Table 8-13 on page 8-37. **If MyFilter.FilterType = FilterTypeStandard Then MsgBox _** **"Attribute-based filter"**
Object	Object: Represents the attribute, measure, or dimension element object on which the FilterElement object is based. **MsgBox MyFilterElement.Object.Name**
Operand	String: Identifies the particular values within the attribute, dimension element, or measure on which to perform an operation for the constraint. Parameters should be enclosed in less-than and greater-than operators, as described above. **MyFilterElement.Operand = "<<Current Period>>"**

Table 8-12 *FilterElement Class of Objects: Properties*

Property	Description/Example
Operator	String: The operator within the constraint definition. Any operator that can be included in the WHERE clause of an SQL statement is acceptable, including the following: =, <, >,<>, <=, >=, in, not in, like, not like, is null, and is not null. The significance of these operators when applied to numeric and string information is explained above. The In operator requires Operand values to be enclosed in parentheses, and separated by commas, as shown in the example for instantiating a Filter-Element object. **MyFilterElement.Operator = "="**
Parent	Object. Filter object. **MsgBox MyFilterElement.Parent.Name**

To instantiate a FilterElement object, you must specify as arguments values for the FilterOn, Operator, and Operand properties:

```
MyFilter.FilterElements.Add "Brand", "In", "('Alden',
'Delmore')"
```

The FilterElement object does not feature any properties, nor does it own any collections.

Table 8-13 summarizes constants stored by the FilterType property of the FilterElement object:

Table 8-13 *FilterType Constants*

Filter Element Type	MetaCons.bas Constant Name	Constant
Other	FilterTypeOther	0
Attribute	FilterTypeStandard	1
Dimension Element	FilterTypeDimensionElement	2
Measure	FilterTypeMeasure	3

The MetaCube Class of Objects

A MetaCube object can best be thought of as a virtual cube of data, as returned by a Query object. Throughout our discussion of the MetaCube object, we will refer to the object as if it actually stores data in a physical cube-like structure. In actuality, MetaCube avoids the expansion problems and lack of sparsity associated with storing data in this format while continuing to handle data as though it were.

Each MetaCube object within the collection owned by a query represents a different way of organizing, summarizing, and pivoting data. The data from a given query, for example, can be presented in a break report, a cross-tabular report, or even organized on different pages with results sub-totaled or averaged. Each new format or calculation manipulates the same set of data returned to the client, and each corresponds to a different MetaCube object within a Query object's collection.

Instantiating a MetaCube Object

Although a MetaCube object ultimately represents the structure storing and manipulating the data returned by a query, you can instantiate a MetaCube object before the query executes, including the name of the object as the only arguments to the Query object's Add method:

```
MyQuery.MetaCubes.Add "My Cube of Data"
```

Please note that if you add multiple instances of a MetaCube object to a collection owned by a single query, the query does not return a separate data set for each MetaCube object. Rather, each instance organizes and manipulates a common set of data in a different way.

General Properties

A standard set of MetaCube object properties describe the MetaCube object generally, identifying the name of the object and its parent. Included in this set are Boolean properties that indicate whether the analytical engine performs grand total calculations on the report represented by the object and whether duplicate values are displayed in break reports.

As an object representing a virtual three-dimensional data structure defined by columns, rows, and pages, the MetaCube object also features properties that:

- describe a particular three-dimensional location within a cube
- retrieve information about a particular cell within the cube
- describe the general three-dimensional structure of a cube

For example, before determining the value of a cell using the Cell property, you must identify the location of the Cell using the Column, Row, and Page properties.

Please note that any MetaCube property or method representing or returning a value that depends on the nature of the data to be retrieved by the query can force the query to execute before or even without deploying that Query object's Retrieve method. The Rows, Columns, Pages, Cell, and CellType properties, as well as the FetchCell, FetchCellType, ToSpreadClip, and ToVBArray methods, all implicitly require a query to execute. Once a query has executed, however, none of these methods require the query to re-execute. For an example of an application that relies on a method of the MetaCube object class to execute a query, see MetaCube API Exercise 3 on page 2-11.

Table 8-14 *MetaCube Class of Objects: General Properties*

Property	**Description/Example**
Name	String: The name of the MetaCube object, as specified upon instantiation. Default property. **MsgBox MyMetaCube.Name**
Parent	Object: Stores the Query object. **MsgBox MyMetaCube.Parent.Name**
Scratch	Boolean: False indicates that the report definition, as represented by the MetaCube object, will be saved with the query definition. The default value, True, indicates that the format of a query's report, including pivoting, subtotals, and sorts will not be saved with the query's definition. **MyMetaCube.Scratch = False**

Table 8-14 *MetaCube Class of Objects: General Properties*

Property	**Description/Example**
Suppress-Duplicates	Boolean. In a report including rows and sub-rows or columns and sub-columns, the values in a row or a column group values in sub-rows or sub-columns. If you want the row or column values duplicated for each value within the sub-row or sub-column, set the SuppressDuplicates property to false. See Table 8-15 on page 8-41 and Table 8-16 on page 8-42. To suppress the duplicate values in grouping rows or columns, set this property to true. Defaults to False. **MyMetaCube.SuppressDuplicates = True**

Table 8-15 displays the results of a query with the SuppressDuplicates property of the MetaCube object set to false

Table 8-15 *Brand, Region Query, Suppress Duplicates Property False*

Brand	Region	Units Sold
Alden	Northeast	1811
Alden	West	2626
Barton	Northeast	1314
Barton	West	1924
Delmore	Northeast	1778
Delmore	West	2557
Extreme	Northeast	433
Extreme	West	649
Lasertech	Northeast	1105
Lasertech	West	1665
NVD	Northeast	2719
NVD	West	3788
Onetron	Northeast	910
Onetron	West	1254
Suresound	Northeast	2548
Suresound	West	3464
Techno Components	Northeast	3699
Techno Components	West	5286

Table 8-16 displays the results of a query in which the SuppressDuplicates property of the MetaCube object has been set to True.

Table 8-16 *Brand, Region Query, Suppress Duplicates Property True*

Brand	Region	Units Sold
Alden	Northeast	1811
	West	2626
Barton	Northeast	1314
	West	1924
Delmore	Northeast	1778
	West	2557
Extreme	Northeast	433
	West	649
Lasertech	Northeast	1105
	West	1665
NVD	Northeast	2719
	West	3788
Onetron	Northeast	910
	West	1254
Suresound	Northeast	2548
	West	3464
Techno Components	Northeast	3699
	West	5286

Properties of the Three-Dimensional Virtual Cube

Table 8-17 summarizes the properties describing three-dimensional characteristics of the MetaCube object.

Table 8-17 *MetaCube Class of Objects: Properties for Identifying Cells in a Virtual Three-Dimensional Space and Sort-Related Properties*

Property	Description/Example
Cell	Variant: Returns the value of a cell within the MetaCube object's virtual cube of data. The particular cell is specified by a set of Row, Column, and Page properties. This property represents the same value retrieved by the MetaCube object's FetchCell method. Either the property or the method can implicitly require a query to execute, if necessary. Read-only. **MsgBox MyMetaCube.Cell**
CellError	Double: For query results extrapolated from a sample table, this property stores the range of error associated with the value of a particular cell. The range varies directly with the confidence with which MetaCube is required to certify that the actual result will fall within that range. As with the Cell property, the particular cell for which MetaCube evaluates the error is specified by a set of Row, Column, and Page properties. This property represents the same value retrieved by the MetaCube object's FetchCellError method. For a complete discussion of sampling, see "The Sample Class of Objects" on page 6-28. This property is read-only. **MsgBox MyMetaCube.CellError**
CellType	Integer: Identifies the type of data in a specified cell. Different integer values correspond to an attribute / dimension element value, a measure value, a subtotal or grand total value, an attribute / dimension element label, a measure label, or a subtotal or grand total label. Table 8-18 on page 8-48 summarizes the significance of each cell type code. This property is read-only, as the type of each cell depends on the definition of the query and the format of the report. **MsgBox MyMetaCube.CellType**
Column	Long integer: identifies a particular column in the virtual cube of data. Defaults to 0. **MyMetaCube.Column = 1**

Table 8-17 *MetaCube Class of Objects: Properties for Identifying Cells in a Virtual Three-Dimensional Space and Sort-Related Properties (continued)*

Property	Description/Example
Columns	Long integer: Returns the number of columns in the virtual cube of data represented by the MetaCube object. See the tutorial application developed in the second chapter of this reference, which defines a range of cells in which to display a result using the MetaCube object's Columns and Rows properties. The number of columns in a virtual cube of data depends on the number of attributes, measures, and dimension elements included in a query and the range of values each represents. This property is thus read-only. **MsgBox MyMetaCube.Columns**
Current-Attribute	QueryCategory object: Represents the attribute / dimension element to which the currently selected or identified attribute / dimension value belongs. **MsgBox MyMetaCube.CurrentAttribute.Name**
FormatStrings	ValueList. An array of formatting commands for each numeric column or row in the query, as set by the FormatString property of the QueryItem and Measure object classes. See "The SortDirection Property" on page 8-22. **MsgBox MyMetaCube.FormatStrings**
Page	Long integer: Identifies a particular page in the virtual cube of data. Defaults to 0. **MyMetaCube.Page = 1**
PageLabels	ValueList. This property stores the names of attribute values appearing in the page orientation for a given page, as defined by the Page property of the MetaCube object. The ValueList will contain multiple values only if more than one QueryCategory has been pivoted to a page orientation. **MsgBox MyMetaCube.PageLabels.TabbedValues**
Pages	Long integer: Represents the number of pages in the virtual cube of data represented by the MetaCube object. **MsgBox MyMetaCube.Pages**
Row	Long integer: Identifies a particular row in the virtual cube of data represented by the MetaCube object. Defaults to 0. **MyMetacube.Row = 1**

Table 8-17 *MetaCube Class of Objects: Properties for Identifying Cells in a Virtual Three-Dimensional Space and Sort-Related Properties (continued)*

Property	Description/Example
Rows	Long integer: Returns the number of rows in the virtual cube of data represented by the MetaCube object. The number of rows depends on the definition of the query and the number of records retrieved by the query. This property is thus read-only. **MsgBox MyMetaCube.Rows**
SortColumn	Long: Indicates the column of numeric data on which to perform a sort, organizing rows according to the numeric value of the measure appearing in each row. Columns are numbered from left to right, beginning with zero at the first column in the report. Pivoting measures to the row orientation does not alter the role of this property. Using this property to identify a column of attribute values returns an error. Assigning a value to this property overrides any sort applied to a QueryCategory organized by rows, as this method sorts rows based on the values of a measure rather than the values of an attribute. And unlike the QueryCategory object's SortDirection property, which sorts attribute values regardless of their position in the report, this property offers developers a powerful way to apply a new sort to an arbitrary numeric column within an existing report. Specifying the column on which to base a sort of rows prior to processing the query can be difficult, as the order in which columns appear depends on the query result. Defaults to -1, directing MetaCube to sort reports based on the SortDirection properties of the Query object's collection of QueryCategories, as documented in "The SortDirection Property" on page 8-22. See also MetaCube API Exercise 23 on page 8-49. In cases where MetaCube sorts numeric data on rows and on columns before the query executes, rows are sorted first. **Let MyMetaCube.SortColumn = 2**

Table 8-17 *MetaCube Class of Objects: Properties for Identifying Cells in a Virtual Three-Dimensional Space and Sort-Related Properties (continued)*

Property	Description/Example
SortColumn-Breaks	Boolean: Indicates how to sort reports in which more than one QueryCategory object has a row orientation. A true value directs MetaCube to perform a numeric sort only on sub-rows, leaving rows unsorted. In this case, only the rows within each break are sorted from small to large numbers or vice-versa. A false value directs MetaCube to sort the entire report so that the smallest numbers appears first and the largest last or vice-versa, regardless of the break to which a sub-row belongs. Defaults to false. For examples, see Table 8-21 on page 8-54. **Let MyMetaCube.SortColumnBreaks = True**
SortColumn-Direction	Long: Indicates the direction in which the column specified by the SortColumn property is sorted, with an ascending sort arranging numbers such that the largest numbers appear at the bottom of the report, and the smallest numbers at the top. Defaults to ascending order. See Table 8-7 on page 8-23 for a list of constants declarations, their significance, and their corresponding numeric values. **MyMetaCube.SortColumnDirection = SortDirectionDesc**

Table 8-17 *MetaCube Class of Objects: Properties for Identifying Cells in a Virtual Three-Dimensional Space and Sort-Related Properties (continued)*

Property	**Description/Example**
SortRow	Long: Indicates the row of numeric data on which to perform a sort, organizing columns according to the numeric value of the measure appearing in each column. Rows are numbered from top to bottom, beginning with zero at the first row in the report. Using this property to identify a row of attribute values returns an error. Assigning a value to this property overrides any sort applied to a QueryCategory organized by columns, as this method sorts columns based on the values of a measure rather than the values of an attribute. Since QueryCategories are sorted before numeric data, changing the sort on a QueryCategory object organized by rows obviously changes the values that appear in any given row specified by this property. Like the SortColumn property of the MetaCube object, this property offers developers a powerful way to apply a new sort to an existing report. Specifying the row on which to base a sort of columns prior to processing the query can be difficult, as the order in which rows appear depends on the query result. Defaults to -1, directing MetaCube to sort reports based on the SortDirection properties of the Query object's collection of QueryCategories, as documented in "The SortDirection Property" on page 8-22. See also MetaCube API Exercise 23 on page 8-49. In cases where MetaCube sorts numeric data on rows and on columns before the query executes, rows are sorted first. **Let MyMetaCube.SortRow = 2**
SortRow-Breaks	Boolean: Indicates how to sort reports in which more than one QueryCategory object has a column orientation. A true value directs MetaCube to perform a numeric sort only on sub-columns, leaving columns unsorted. In this case, only the columns within each break are sorted from small to large numbers or vice-versa. A false value directs MetaCube to sort the entire report so that the smallest numbers appears first and the largest last or vice-versa, regardless of the break to which a sub-column belongs. Defaults to false. For examples, see Table 8-21 on page 8-54. **MyMetaCube.SortRowBreaks = True**

Table 8-17 *MetaCube Class of Objects: Properties for Identifying Cells in a Virtual Three-Dimensional Space and Sort-Related Properties (continued)*

Property	Description/Example
SortRow-Direction	Long: Indicates the direction in which the row specified by the SortRow property is sorted, with an ascending sort arranging numbers such that the largest numbers appear in columns at the right of the report and the smallest numbers in columns at the left. Defaults to ascending order. See Table 8-7 on page 8-23 for a list of constants declarations, their significance, and their corresponding numeric values. **MyMetaCube.SortRowDirection = SortDirectionDesc**
Value	Variant: Returns the value of a specified cell. This property is identical to the Cell property but included for compatibility with Visual Basic controls. **MsgBox MyMetaCube.Value**

Related Numeric Constants

Table 8-18 explains the numeric values returned by the CellType property and their associated constants.

Table 8-18 *MetaCube Class of Objects: Numeric Values for The CellType Property*

Cell Contents	MetaCons.bas Constant Name	Constant
Empty	CellTypeEmpty	0
QueryCategory name	CellTypeCategoryLabel	1
QueryCategory value	CellTypeCategoryValue	2
Label for column or row containing calculated information	CellTypeSummaryLabel	3
Calculated data, such as subtotals or grand totals	CellTypeSummaryValue	4
Measure name	CellTypeQueryItemLabel	5
Numeric measure value	CellTypeQueryItemValue	6

Sorting: SortDirection and SortColumn Property

Sorting a standard query in different ways and iteratively executing reports demonstrates MetaCube's complex sorting features, as shown in MetaCube API Exercise 23. Before executing the procedures in this exercise, you must create three spreadsheets, named "Sort on Brand," Sort on Measure," and "Sort on Brand Again" because the Sort procedure attempts to create reports in sheets with these names.

MetaCube API Exercise 23: Sorting

```
Sub Sorting()

'Declare Variables and Constants
Dim MyMetabase As Object, MyQuery As Object, _
    MyMetaCube As Object, MyData As Variant
Const OrientationColumn = 2
Const SortDirectionDesc = 2

'Login
Set MyMetabase = CreateObject("Metabase")
MyMetabase.Connect

'Define Query
Set MyQuery = MyMetabase.Queries.Add("Untitled1")
MyQuery.QueryCategories.Add "Brand"
MyQuery.QueryCategories.Add "Region"
MyQuery.QueryCategories.Item("Region").Orientation _
         = OrientationColumn
MyQuery.QueryItems.Add "Units Sold"

'Sort on Brand
MyQuery.QueryCategories.Item("Brand").SortDirection _
        = SortDirectionDesc
'Build Initial Report
Set MyMetaCube = MyQuery.MetaCubes.Add("Report1")
Worksheets.Item("Sort on Brand").Activate
RunQuery MyMetaCube 'Calls a procedure for executing query

'Resort
MyMetaCube.SortColumnDirection = SortDirectionDesc
MyMetaCube.SortColumn = 1
'Rebuild Report
Worksheets.Item("Sort on Measure").Activate
RunQuery MyMetaCube
```

```
30 'It Was No Fluke:  Resort on Brand
31 MyQuery.QueryCategories.Item("Brand").SortDirection _
32         = SortDirectionDesc
33 'Rebuild Report Again
34 Worksheets.Item("Sort on Brand Again").Activate
35 RunQuery MyMetaCube 'No effect: SortColumn overrides!
36 End Sub

37 Sub RunQuery(MyMetaCube)
38     'Declare Variables
39     Dim ReportRange As Range, MyData As Variant
40     'Transform Data in Cube into VB Array
41     Let MyData = MyMetaCube.ToVBArray
42     'Import Data into Excel Spreadsheet
43     Set ReportRange = _
44         ActiveSheet.Range _
45         (ActiveSheet.Cells(1, 1), _
46         ActiveSheet.Cells _
47         (MyMetaCube.Rows, MyMetaCube.Columns))
48     Let ReportRange.Value = MyData
49     ReportRange.EntireColumn.AutoFit  'Sizes columns
50 End Sub
```

Explanation of MetaCube API Exercise 23

Unlike previous exercises, this exercise involves a subroutine. The main procedure, Sorting, defines a query on *Brand* and *Region*, pivoting the *Region* attribute to the column orientation. The rows of the report are first sorted by *Brand*, using the QueryCategory object's SortDirection property, then sorted by measure, using the SortColumn property of the MetaCube object. Finally the sort on *Brand* is applied again to ascertain whether the order in which the commands are issued determines which property takes precedence.

Each sort generates a different MetaCube object, all of which are stored by the object variable MyMetaCube and processed by the subroutine RunQuery, which begins on line 37. Lines 23, 29, and 35 all call this subroutine. When the RunQuery subroutine completes, the Sort procedure resumes execution at the point in the Sort procedure from which the call to that subroutine was made. Since all variables are declared locally, we must explicitly pass to the RunQuery subroutine any variables that the subroutine requires, in this case, the object variable MyMetaCube.

This exercise generates three reports. In the first report, generated by lines 18 through 22, the SortDirection property of the *Brand* QueryCategory sorts brands in a descending order:

Table 8-19 *Brand Sales by Region, Descending Sort on Brand Names (SortDirection Property of* Brand *QueryCategory*

Region	**Northeast**	**West**
Brand	Units Sold	Units Sold
Techno Components	3699	5286
Suresound	2548	3464
Onetron	910	1254
NVD	2719	3788
Lasertech	1105	1665
Extreme	433	649
Delmore	1778	2557
Barton	1314	1924
Alden	1811	2626

As Table 8-19 illustrates, a descending sort on the *Brand* attribute organizes the rows of the report such that brands appear in reverse-alphabetic order. Ordering the same rows by a different criterion, such as the numeric values within a particular column, abrogates the SortDirection property of the *Brand* QueryCategory in lieu of the SortColumn property of the MetaCube object. Although the SortColumnDirection property stores the same numeric constant, sorting brands according to how well they sold rather than the alphabetic order of their names obviously alters the arrangement of rows in the report.

In our case, line 26 identifies column one, or, since we count from zero, the second column from the left, as the column of numeric data on which to base our sort. As a result, the sort will be based on brands' sales in the Northeast rather than the West region. Since both regions manifest the same trend in brand sales, this distinction is meaningless in this context:

Table 8-20 *Brand Sales by Region, Descending Sort on Brand Sales in Northeast (SortColumnProperty of MetaCube Object)*

Region	**Northeast**	**West**
Brand	Units Sold	Units Sold
Techno Components	3699	5286
NVD	2719	3788
Suresound	2548	3464
Alden	1811	2626
Delmore	1778	2557
Barton	1314	1924
Lasertech	1105	1665
Onetron	910	1254
Extreme	433	649

As Table 8-20 indicates, the SortColumn and SortRow properties of the MetaCube object override any conflicting sorts applied by the SortDirection property of the QueryCategory object.

MetaCube applies sorts on attribute values first and on numeric data second. This becomes important when performing sorts that are orthogonal to one another. Reversing the sort on a QueryCategory organized by columns changes the column specified by a SortColumn property; in our example, brands stored in rows would be arranged according to how well they sold in the West rather than in the Northeast region.

To confirm that the order in which sort commands are issued is immaterial when two sorts are both applied to columns or both applied to rows, we re-apply the sort to the *Brand* QueryCategory on lines 31 and 32. The report generated by this query is identical to its predecessor, shown as Table 8-20.

In the unlikely event that a user specifies values for both the SortColumn property and the SortRow property of a single MetaCube object, MetaCube organizes columns first according to the relative values of a measure in a specified row; MetaCube then re-arranges the order of the rows based on the relative values of a measure in a specified column. The SortRow property can thus determine the column on which the sorting of rows is based.

Whenever you perform numeric sorts on reports that organize multiple QueryCategory objects by either rows or columns, you must also use the SortColumnBreaks and SortRowBreaks properties to indicate whether multiple QueryCategories or only one QueryCategory should be affected by the numeric sort. Table 8-21 on page 8-54 displays the result of a query executed with the SortColumnBreak property set to false.

Table 8-21 *Brand, Query Query: Sort on Numeric Column, SortColumnBreaks Set to False*

Brand	Region	Units Sold
Extreme	Northeast	433
	West	649
Onetron	Northeast	910
Lasertech	Northeast	1105
Onetron	West	1254
Barton	Northeast	1314
Lasertech	West	1665
Delmore	Northeast	1778
Alden	Northeast	1811
Barton	West	1924
Suresound	Northeast	2548
Delmore	West	2557
Alden	West	2626
NVD	Northeast	2719
Suresound	West	3464
Techno Components	Northeast	3699
NVD	West	3788
Techno Components	West	5286

With the exception of the Extreme brand, whose sales were uniformly weak in both regions, the rows of the report in Table 8-21 have been sorted without concern for displaying each brand's sales contiguously. Compare this to the report displayed in Table 8-22. Here, the order in which brand names appear is unaffected by the sort:

Table 8-22 *Brand, Query Query: Sort on Numeric Column, SortColumnBreaks Set to True*

Brand	**Region**	**Units Sold**
Alden	Northeast	1811
	West	2626
Barton	Northeast	1314
	West	1924
Delmore	Northeast	1778
	West	2557
Extreme	Northeast	433
	West	649
Lasertech	Northeast	1105
	West	1665
NVD	Northeast	2719
	West	3788
Onetron	Northeast	910
	West	1254
Suresound	Northeast	2548
	West	3464
Techno Components	Northeast	3699
	West	5286

The SortRowBreaks property serves the same purpose, determining how MetaCube performs numeric sorts on reports with multiple QueryCategory objects organized by columns.

MetaCube Methods

The MetaCube object features a variety of methods to render data in different formats for different development environments. The MetaCube object's methods enable users to easily drill down or drill up to different levels of detail in a report. Table 8-23 explains the methods of the MetaCube class of objects.

Table 8-23 *MetaCube Class of Objects: Methods*

Method	Description/Example
AddDrill	This method adds a new attribute value on which the analysis engine drills down or drills up, referring to the current Row, Column, and Page properties of the MetaCube object to identify that attribute value in the report. **MyMetaCube.AddDrill**
ClearDrills	This method removes any previous row, page, or column references to cells on which the analysis engine has been set to drill down or to drill up. **MyMetaCube.ClearDrills**
ClearSorts	This method abrogates any sort assigned by the SortColumn or SortRow properties of the MetaCube class of objects. Please note that this method does not abrogate sorts assigned by the SortDirection property of the QueryCategory class of objects. **MyMetaCube.ClearSorts**
Copy	This method copies the MetaCube object as a new instance of the same class, with the same properties, orientations, sorts, and summaries as the source object. The Scratch property of the new object is set to true. **Set MetaCopy = MyMetaCube.Copy**

Table 8-23 *MetaCube Class of Objects: Methods (continued)*

Method	Description/Example
DrillDown	Returns a new object of the MetaCube object class, implicitly defining a new query to retrieve detail-level data for a specified attribute value or set of attribute values. Referring to the row, column, and page properties of the MetaCube object, the AddDrill method identifies each value on which the analysis engine drills. This method requires two arguments, the item within the collection of DrillDownAttributes to which to drill from the selected attribute value(s) and a Boolean flag indicating whether to include in the new report the value(s) on which MetaCube drilled: **Set DetailCube = MyMetacube.DrillDown _ (MyMetacube.DrillDownAttributes.Item(0), True)** See MetaCube API Exercise 24 on page 8-63 and the explanation that follows for a more thorough discussion of drilling down.
DrillUp	Returns a new object of the MetaCube object class, implicitly defining a new query to retrieve summary-level data for a specified attribute value or set of attribute values. Referring to the row, column, and page properties of the MetaCube object, the AddDrill method identifies each value on which the analysis engine drills. This method requires one argument, the item within the collection of DrillDownAttributes to which to drill from the selected attribute value(s): **Set DetailCube = MyMetacube.DrillDown _ (MyMetacube.DrillDownAttributes.Item(0), True)** See below for a more thorough discussion of drilling up.
Error-SpreadClip	This method returns as a tab-delimited string the error associated with a query result that has been extrapolated from a sample table. Query results extrapolated from sample tables include a range of error for each numeric value within the result. Attribute values and other non-numeric cells within the report return null values. For queries that do not process against a sample table, the ErrorSpreadClip method returns null values for all cells. For more information about sampling, query confidence, and error, see "The Sample Class of Objects" on page 6-28. The ErrorSpreadClip method requires the same arguments as the more common ToSpreadClip method, documented below. **Spread1.ClipValue = MyMetaCube.ErrorSpreadClip _ (1, MyMetaCube.Rows)**

Table 8-23 *MetaCube Class of Objects: Methods (continued)*

Method	Description/Example
ErrorVBArray	For each value in an extrapolated query result, this method returns a margin of error, assembling the error values in a two- or three-dimensional variant array that can be stored by a Visual Basic 4.0 or Visual Basic for Applications variant or array variable. This method returns null values for queries that are not processed against a sample table. Non-numeric cells in a query result also return null error values, regardless of the table from which the result was retrieved or derived. For numeric query results that are extrapolated from a sample table, the error can be added or subtracted to that result, defining a range within which the actual value is likely to fall. The confidence with which MetaCube is required to certify that the actual result will fall within that range determines the size of the range. For more information about sampling, query confidence, and error, see "The Sample Class of Objects" on page 6-28. The ErrorVBArray method can implicitly require MetaCube to execute a query. **Dim QueryData as Variant** **QueryData = MyMetaCube.ErrorVBArray**
FetchCell	Like the Cell property, this method returns as a variant the value of a specific cell within the virtual cube of data represented by a MetaCube object. You must specify as arguments the row, column and page number of the desired cell, in that order. Deploying this method before executing the query implicitly commands the MetaCube engine to execute the query. Please note that this method involves building the entire virtual cube on the client, and limits on the number of rows a query can retrieve still apply. **MyVariantValue = MyMetaCube.FetchCell (1, 1, 1)**

Table 8-23 *MetaCube Class of Objects: Methods (continued)*

Method	Description/Example
FetchCellError	Like the CellError property, this method returns a number of the double type, indicating the error associated with a single value within an extrapolated query result. This method returns null values for queries that are not processed against a sample table. This method also returns null values for cells that are non-numeric, such as those that contain attribute values. For numeric query results that are extrapolated from a sample table, the error can be added or subtracted to the statistically-predicted value, defining a range within which the actual value is likely to fall. The confidence with which MetaCube is required to certify that the actual result will fall within that range determines the size of the range. For more information about sampling, query confidence, and error, see "The Sample Class of Objects" on page 6-28. This method, which can prompt MetaCube to execute a query, requires three arguments, specifying the row, column, and page number of the desired cell, in that order. **CellError = MyMetaCube.FetchCellError 1, 1, 1**
FetchCellType	Like the CellType property, this method returns an integer indicating the type of data a cell stores, whether it be a measure label, an attribute label, a measure, a value, etc. Table 8-18 on page 8-48 explains the significance of the integers returned by this method. This method requires the same arguments as the FetchCell method, and they must be specified in the same order. **CellCode = MyMetaCube.FetchCellType(1, 1, 1)**

Table 8-23 *MetaCube Class of Objects: Methods (continued)*

Method	Description/Example
ToSpreadClip	This method translates the data stored in the virtual cube represented by a MetaCube object into a tab-delimited string, which you can readily export to the popular Spread / VBX custom control. Deploying this method before executing the query implicitly commands the MetaCube engine to execute the query. **Spread1.Col = 1** **Spread1.Row = 1** **Spread1.Col2 = MyMetaCube.Columns** **Spread1.Row2 = MyMetaCube.Rows** **Spread1.ClipValue = MyMetaCube.ToSpreadClip _** **(1, MyMetaCube.Rows)** This example includes optional arguments. One specifies the row within the cube at which to begin exporting data, the other specifies the number of rows to export, where the default is all rows. Using these arguments to iteratively specify different chunks of data allows you to export large data sets to Spread / VBX.
ToVBArray	This method translates the data represented by the MetaCube object as a virtual cube into a two- or three-dimensional variant array that can be stored in a Visual Basic 4.0 or Visual Basic for Applications array or variant variable. This method can implicitly require MetaCube to execute a query. For an example of such an application, see MetaCube API Exercise 3 on page 2-11. **Dim QueryData as Variant** **QueryData = MyMetaCube.ToVBArray**

The DrillDown Method

Drilling down enables you to navigate easily from a cell in a report to greater levels of detail, as displayed in a new report of the same format. The DrillDown method of the MetaCube object class instantiates, defines and executes a new Query object identical to the parent of the MetaCube object except that one of the attributes in the original query is replaced by an attribute describing a lower level in the dimensional hierarchy.

Moreover, the new Query object includes a filter against the attribute on which you are drilling, retrieving only values within the range defined by the cells selected in the original report. If, in a monthly sales report, you drill down on the value July, the resulting report would be grouped by the attribute describing the next level of detail within the time dimension, but only for the month of July—that is, only the days July 1 through July 31. Using the AddDrill method of the MetaCube object class, you can specify more than one attribute value on which to drill, expanding the scope of the new, detail-level report.

The analytical engine generates a new MetaCube object to represent the data returned by the new query. The new MetaCube object features the same properties and describes the same report format as the previous MetaCube object, substituting the detail-level attribute for the summary-level attribute.

You can drill down on only values of a single attribute within the virtual cube represented by the MetaCube object. For each attribute value you must identify the cell containing such a value, defining its location in the three-dimensional virtual cube:

```
MyMetaCube.Column = 0
MyMetaCube.Row = 1
MyMetaCube.Page = 0
```

Once you have identified a cell storing an attribute value, you can deploy the AddDrill method:

```
MyMetaCube.AddDrill
```

This method requires no arguments, as the Column, Row, and Page properties of the MetaCube object already identify the cell on which to drill. For each value within an attribute on which you want to drill, you must specify a different cell using these properties, followed by the same AddDrill method. For a given MetaCube object, you cannot add drill directions for values of different attributes. Although you cannot view as a collection or ValueList the cells on which you are drilling, the values on which MetaCube drills are cumulative—the AddDrill method does not replace one value with the next. Once you have specified a cell on which to drill, you can exclude that cell from MetaCube’s drill path only by clearing all drill paths using the ClearDrills method.

```
MyMetaCube.ClearDrills
```

Before deploying the DrillDown method, you must have identified at least one cell on which to drill, using the Row, Column and Page properties of the MetaCube object. The DrillDown method requires two arguments, the Attribute object to which you would like to drill, specified as an object, and a flag indicating whether existing attribute values should be included in the new report. This method returns a new MetaCube, named after the original MetaCube object, the parent of which is the new Query object. To execute the query, invoke the ToVBArray or ToSpreadClip method:

```
Set DetailLevelCube = MyMetaCube.DrillDown _
     (MyMetaCube.DrillDownAttributes.Item(0), True)
```

MyMetaCube's collection of DrillDownAttribute objects includes the default attributes to which you can drill for a specified cell. See Table 8-24 on page 8-68. You can also specify the attribute on which to drill down by referring to the collection of attributes owned by a Dimension object.

DrillUp Method

Like the DrillDown method, this method returns a new instance of the MetaCube object with a new parent; both the Query object and the MetaCube object are identical to the original Query and MetaCube objects except that they represent data at a higher level of summarization.

Although the value or set of values from which you drill up in a report describes a particular level in the dimensional hierarchy—defining the collection of DrillUpAttributes—the resulting query is not filtered on that value. The new query thus retrieves data at a higher level of summarization but with the same scope. Since the subsequent query is not filtered on the selected attribute value(s), it is unnecessary to select more than one cell on which to drill.

As with the previous method, you must establish the cell from which you are drilling before deploying this method, using the Row, Column, and Page properties of the MetaCube object:

```
MyMetaCube.Row = 1
MyMetaCube.Column = 0
MyMetaCube.Page = 0
MyMetaCube.AddDrill
```

After specifying a cell on which to drill, deploy the AddDrill method. As with the DrillDown method, you cannot drill up from values of different attributes. The attribute values added to the drill path correspond to a particular level in the dimensional hierarchy, defining the collection of attributes reachable via the DrillUp method from that cell. We use this collection to specify the new Attribute object. The DrillUp method substitutes one of the attributes from this collection for the attribute on which you are drilling up from:

```
Set DrillUpCube = MyMetaCube.DrillUp _
    (MyMetaCube.DrillUpAttributes.Item(0))
```

The DrillUp method returns a new MetaCube object named after the original MetaCube object, the parent of which is the new Query object. To execute the query, deploy the ToVBArray or ToSpreadClip method.

MetaCube API Exercise 24 illustrates many of the methods and properties used for drilling down and drilling up. The procedures in this exercise create a simple break report, with Brand organized by rows and Region by columns, and then drill down, first on Brand and then on Region.

MetaCube API Exercise 24: Drilling Down

```
Option Explicit

Sub DrillDown()

'Declare Variables and Constants
Dim MyMetabase As Object, MyQuery As Object, _
    MyMetaCube As Object
Const OrientationColumn = 2

'Login
Set MyMetabase = CreateObject("Metabase")
MyMetabase.Connect

'Define Query
Set MyQuery = MyMetabase.Queries.Add("Untitled1")
MyQuery.QueryCategories.Add "Brand"
MyQuery.QueryCategories.Add "Region"
MyQuery.QueryCategories.Item("Region").Orientation _
         = OrientationColumn
MyQuery.QueryItems.Add "Units Sold"

'Build Initial Report
Set MyMetaCube = MyQuery.MetaCubes.Add("Report1")
Worksheets.Item("Original Report").Activate
```

```
'Call Procedure for Executing Query
RunQuery MyMetaCube

'Drill Down on Two Brands
'Add First Drill Value
    MyMetaCube.Row = 2 'First row has index number of zero
    MyMetaCube.Column = 0
    MyMetaCube.Page = 0
    MyMetaCube.AddDrill

'Add Second Drill Value
    MyMetaCube.Row = 3
    MyMetaCube.Column = 0
    MyMetaCube.Page = 0
    MyMetaCube.AddDrill

'Drill Away!
Set MyMetaCube = MyQuery.MetaCubes.Item("Report1") _
    .DrillDown (MyQuery.MetaCubes.Item("Report1") _
    .DrillDownAttributes.Item(0), _
    True)
MsgBox MyMetaCube.Parent 'Not the original query
Worksheets.Item("Drill Down").Activate 'New worksheet

'Call Procedure for Executing Query
RunQuery MyMetaCube

'Drill Down on Region, From the Original Report

'Get Rid of Old Drills
MyQuery.MetaCubes.Item("Report1").ClearDrills

'Add Drill on a Region
    MyQuery.MetaCubes.Item("Report1").Row = 0
    MyQuery.MetaCubes.Item("Report1").Column = 1
    MyQuery.MetaCubes.Item("Report1").Page = 0
    MyQuery.MetaCubes.Item("Report1").AddDrill

'Drill Away!
Set MyMetaCube = MyQuery.MetaCubes.Item("Report1") _
  .DrillDown (MyQuery.MetaCubes.Item("Report1") _
  .DrillDownAttributes.Item(0), True)
Worksheets.Item("DrillDown Again").Activate

'Call Procedure for Executing Query
RunQuery MyMetaCube

End Sub

Sub RunQuery(MyMetaCube)

    'Declare Variables
    Dim ReportRange As Range, MyData As Variant
```

```
61      'Transform Data in Cube into VB Array
62      Let MyData = MyMetaCube.ToVBArray

63      'Import Data into Excel Spreadsheet
64      Set ReportRange = _
65          ActiveSheet.Range _
66          (ActiveSheet.Cells(1, 1), _
67          ActiveSheet.Cells _
68          (MyMetaCube.Rows, MyMetaCube.Columns))
69      Let ReportRange.Value = MyData
70      ReportRange.EntireColumn.AutoFit  'Sizes columns

71  End Sub
```

Explanation of MetaCube API Exercise 24

Like the previous exercise, this exercise involves two separate procedures. The first procedure, DrillDown, defines a query and drills down on two different attributes, instantiating three MetaCube objects to store the result, all of which are stored in the object variable MyMetaCube. The DrillDown procedure is the main procedure and begins on line 4.

The second procedure, RunQuery, retrieves as an array the data represented by the three MetaCube objects defined in the main procedure, displaying that data in the currently active spreadsheet. This procedure begins on line 61. The DrillDown procedure calls the RunQuery procedure from lines 21, 41, and 56. Each call passes the object variable MyMetaCube to the RunQuery procedure. When the RunQuery procedure completes, the DrillDown procedure resumes execution at the point from which the call was made. As a subroutine to the main procedure, RunQuery cannot be executed independently.

The DrillDown procedure begins by declaring a set of object variables for storing Metabase, Query, and MetaCube objects. All variables are declared locally, requiring us to explicitly pass to the second procedure any variables that the subroutine requires. Line 6 declares a constant that we will later use to pivot the Region attribute to the column orientation.

We connect to the database on line 9, instantiating a multi-dimensional view of relational data in a Metabase object. As in previous exercises, no Metabase properties are set and connect parameters default from the metacube.ini file. Lines 12 to 16 define the familiar *Brand, Region* query, and lines 18-19 instantiate a MetaCube object to represent the report. Although this MetaCube object will differ from the objects that drilling down subsequently instantiates, the same object variable, MyMetaCube, iteratively stores each of the three objects.

Before calling the RunQuery subroutine, the main procedure activates a worksheet, to which the subroutine returns data. With each call to the subroutine, a different worksheet is active, ensuring that no result overwrites its predecessor. Prior to running the main DrillDown procedure, you must have created three worksheets with the names “Original Report,” “Drill Down,” and “Drill Down Again.”

Line 21 calls the RunQuery subroutine to execute the query, passing the MetaCube object as an argument to the second procedure, which begins on line 60.

We now shift our attention to this subroutine. Because the calling application must pass the object variable MyMetaCube to the RunQuery subroutine, the MyMetaCube object variable appears in the parentheses following the name of the procedure.

On line 62, the RunQuery procedure declares two variables, one to store data from MyMetaCube, the other to define a range of cells in which that data is displayed. Line 62 prompts MetaCube to retrieve data from the database as the ToVBArray method returns data as an array to the MyData variant variable. Lines 64 to 70 define a report range based on the number of rows and columns in the query result and assign each value in the array to a different cell in the spreadsheet. At the end of this procedure on line 70, the DrillDown procedure resumes execution, on line 22.

Using the Row, Column, and Page properties, lines 24 to 26 define a position within the original MetaCube object’s multi-dimensional structure that stores an attribute value, in this case the “Alden” brand. Upon specifying a cell, line 27 invokes the AddDrill method, thereby including that attribute value in the group of attribute values on which the DrillDown method will act. In a similar fashion, lines 28 to 32 include a second attribute value, “Barton,” in this group. The DrillDown method on line 35 thus retrieves detailed information for two brands, Alden and Barton.

Once the cells on which to drill are set, we can deploy the DrillDown method. Drilling down instantiates a new MetaCube object with a new parent, a Query object with characteristics identical to its predecessor's, except that a new filter has been applied to include data only for the values being drilled down on, and a new, lower-level QueryCategory has been included to show data in more detail.

For efficiency, the MyMetaCube object variable stores the new MetaCube object, replacing the original MetaCube object. Although the application itself obviates the original MetaCube object, it is preserved in memory by the analysis engine as an item within a collection. Immediately we must refer to this object in line 36, as the original MetaCube object's collection of DrillDown attributes determines which attributes are available for inclusion in the drill down query.

This collection of DrillDown attributes consists of the default attributes for each dimension element one level below the level of the attribute on which we drilled. In this case, there is only one dimension element directly below the level of the *Brand* attribute, and that dimension element's default attribute is *Product*. We thus specify the first and only item within this collection as our drill down attribute. The second argument in this statement, a Boolean flag set to True, directs MetaCube to include the attributes on which we are drilling in the new drill down report.

Line 38 displays in a MessageBox the parentage of the new MetaCube object, displaying the generic name of the new Query object generated by the DrillDown method. After activating a new worksheet, the procedure again calls the RunQuery subroutine, retrieving data for the MetaCube object as before.

After executing the new query, the DrillDown procedure resumes on line 44, using the ClearDrills method to eliminate the attribute values of the previous query from the drill path. The original MetaCube must be identified as an item within a collection, as the object variable MyMetaCube now stores the MetaCube object generated by the first drill down.

Otherwise, this section of code, which is included only to demonstrate that the original MetaCube object remains in memory, is identical to the previous section; a position is defined within the multi-dimensional result set of the original MetaCube object, a drill direction is added, and then MetaCube drills down from that position to a specified attribute, again preserving in the new report the value on which the analysis engine drills.

MetaCube Collections

The objects within the MetaCube object's collections allow you to perform different calculations and manipulations on a given set of data without re-querying the database. Also included as denormalized, read-only collections of the MetaCube object are collections describing the attributes to which you can drill up or drill down from different cells within the virtual cube of data represented by the MetaCube object. The latter collections can really be thought of as belonging to different cells within a cube, as their content changes from cell to cell.

Table 8-24 summarizes the MetaCube object's collections.

Table 8-24 *MetaCube Class of Objects: Collections*

Collection	Description/Example
DrillDown-Attributes	Consists of a subset of Attribute objects to which you can drill down from a given cell. The composition of the collection depends on the cell specified by the Row, Column, and Page properties of the MetaCube object. The collection thus changes from cell to cell, as identifying a cell containing a value of an attribute different than the previous cell changes the collection of attributes reachable via drill down from that cell. You cannot directly add or delete Attribute objects to this collection.
DrillUp-Attributes	Consists of a subset of Attribute objects to which you can drill up to from a given cell. The composition of the collection depends on the cell specified by the Row, Column, and Page properties of the MetaCube object. The collection thus changes from cell to cell, as identifying a cell containing a value of an attribute different than the previous cell changes the collection of attributes reachable via drill up from that cell. You cannot directly add or delete Attribute objects to this collection.

Table 8-24 *MetaCube Class of Objects: Collections (continued)*

Collection	Description/Example
Summaries	Consists of objects that subtotal break reports. For example, a report subdividing brand sales by region could perform a subtotal on the QueryCategory object representing Brand, calculating each brand's total or average sales for all regions and storing the result in a row interpolated at each Brand value. Summary objects can also perform grand totals on columns or rows, as well as minimums, maximums, counts, and averages. When instantiating a Summary object, you must include as arguments the QueryCategory object and a constant indicating the type of calculation to perform on each grouping within the report. **MyMetaCube.Summaries.Add MyQueryCategory, _ SummaryTotal**

The Summary Class of Objects

For MetaCube objects that represent break reports, the Summary object performs calculations on the attribute values within a larger grouping, summing, averaging, or counting their associated records. For weekly sales, subdivided by state, you can calculate the average state sales for each week, the total state sales for each, or the number of states for which sales are recorded each week. To perform any of these calculations, we instantiate a Summary object, specifying the QueryCategory object representing the *Week* attribute as the attribute for which we want to perform the calculations. A second argument indicates the type of calculation to perform on the values within each *Week* grouping:

```
MyMetaCube.Summaries.Add MyQueryCategory, SummaryTotal
```

The Summary object can also calculate grand totals, averages, counts, minimums and maximums for all columns or all rows, in which case the first argument is null, irrespective of the groupings within a break report. Should we want to perform several different calculations on the same QueryCategory object, we simply instantiate additional Summary objects, specifying a different type of calculation for each. Each of the arguments in the instantiation command correspond to a Summary object property, as explained in Table 8-25

Table 8-25 *Summary Class of Objects: Properties*

Properties	**Description/Example**
Query-Category	Object: Identifies the QueryCategory object representing the attribute for which the calculation is to be performed. All sub-rows within the grouping defined by values of the attribute will be summed, averaged, or counted. **Set MySummary.QueryCategory = MyQueryCategory**
Parent	Returns the MetaCube object. **MsgBox MyMetaCube.Parent.Name**
SummaryType	Integer: Indicates the type of calculation to perform, as correlated to the numeric values identified in Table 8-26. **MsgBox MyMetaCube.SummaryType = SummaryCount**

Table 8-26 summarizes the constants for the SummaryType property.

Table 8-26 *Summary Class of Objects: SummaryType Constants*

Type of Summarization	**MetaCons.bas Constant Name**	**Constant**
Subtotal	SummaryTotal	1
Average	SummaryAverage	2
Count	SummaryCount	3
Minimum	SummaryMin	4
Maximum	SummaryMax	5
Grand Total, All Rows	SummaryRowGrandTotal	11
Average, All Rows	SummaryRowGrandAverage	12

Table 8-26 *Summary Class of Objects: SummaryType Constants (continued)*

Type of Summarization	MetaCons.bas Constant Name	Constant
Count, All Rows	SummaryRowGrandCount	13
Minimum Value, Among All Rows	SummaryRowGrandMin	14
Maximum Value, Among All Rows	SummaryRowGrandMax	15
Grand Total, All Columns	SummaryColumnGrandTotal	21
Average, All Columns	SummaryColumnGrand-Average	22
Count, All Columns	SummaryColumnGrandCount	23
Minimum Value, Among All Columns	SummaryColumnGrandMin	24
Maximum Value, Among All Columns	SummaryColumnGrandMax	25

Summary objects that calculate subtotals and averages require you to specify the name of the attribute for which to calculate the average or subtotal. But, as Table 8-26 indicates, the Summary object can perform many calculations that do not require a QueryCategory object as an argument. In place of a QueryCategory object, Visual Basic developers can simply write **Nothing** or some other value that the development environment's editor will accept.

The Summary object does not feature any methods, nor does it own any collections.

The QueryBackJob Class of Objects

Submitting a query for background processing instantiates a QueryBackJob object with the same name as the saved query. Please note that the Query-BackJob object does not feature an add method, as each job is submitted and retrieved by deploying Query object methods.

The Metabase object organizes its QueryBackJob collection by user, only showing those QueryBack jobs submitted by a particular user. You cannot create public QueryBackJobs. The Query object organizes its QueryBackJob collection by query, such that each collection only consists of the QueryBackJobs spawned from that Query object.

QueryBackJob Properties

The properties of a QueryBackJob describe the status of a query submitted to QueryBack. After a user submits a query to QueryBack, a server-side scheduling daemon that periodically rouses to identify any new jobs will assign the query a unique job identification number. If the user schedules the job to run immediately, the scheduling daemon places the job on a queue of jobs submitted by other users, arranging jobs on the queue according to their priority. When a server processor becomes available, the scheduling daemon spawns a process to execute the query, storing the result on the database. If a user schedules a job to run in the future, the scheduling daemon stores the query's definition until the time specified, at which time the job is placed on the queue as before.

Because all of the properties of a QueryBackJob depend on the status of server-side processes, you cannot assign values to these properties and they are, in effect, read-only. To retrieve values for a QueryBackJob's properties, you must first deploy the RefreshStatus method, as explained below.

Table 8-27 summarizes the property of the QueryBackJob class of objects:

Table 8-27 *QueryBackJob Class of Objects: Properties*

Property	**Description/Example**
ErrorCode	Integer: Stores any error codes returned by the server while processing a QueryBack job. **MsgBox MyQueryBackJob.ErrorCode**
ErrorText	String: Stores any error message returned by the server while processing a QueryBack job. **MsgBox MyQueryBackJob.ErrorText**

Table 8-27 *QueryBackJob Class of Objects: Properties (continued)*

Property	**Description/Example**
JobID	Long integer: The unique identification number assigned to each QueryBack job by the scheduling daemon upon submission. **MsgBox MyQueryBackJob.JobID**
Name	String: Indicates the name of the QueryBack job, which corresponds to the original name of the Query object submitted for background processing. The default property. **MsgBox MyQueryBackJob.Name**
Parent	Object: Metabase object. **MsgBox MyQueryBackJob.Parent.Name**
Priority	Integer: Indicates the priority assigned to the job upon submission. **If MyQueryBackJob.Priority > 3 _** **Then MsgBox "Query will run soon."**
RecurType	Integer: Indicates the frequency with which the scheduler will re-execute the query, as signified by the numeric values explained in Table 8-3 on page 8-18. Each recurrence of a QueryBack job essentially automatically instantiates a new job, with a new identification number, etc. Defaults to no recurrence. **If MyQueryBackJob.RecurType = RecurTypeNone _** **Then MsgBox"The query not scheduled to run again."**
Size	Long, read-only: This property stores the number of rows that a QueryBackJob object will return to the client. If the QueryBackJob has not executed on the server, the value of this property is 0. **MsgBox MyQueryBackJob.Size**
StartTime	Date variant: Indicates the time at which the QueryBack job actually began processing on the server. Null, pending execution. **MsgBox MyQueryBackJob.StartTime**

***Table 8-27** QueryBackJob Class of Objects: Properties (continued)*

Property	Description/Example
Status	Integer: Indicates whether a QueryBack is pending, executing, or complete, as signified by one of the numeric constants described in Table 8-28 on page 8-74. Jobs that have been submitted to run at a later date, as well as jobs on the scheduler's queue, are identified as pending. **MsgBox MyQueryBackJob.Status**
StopTime	Date variant: Indicates the time at which the server finished processing the query. **MsgBox MyQueryBackJob.StopTime**
SubmitTime	Date variant: Indicates the time at which the user submitted the job. **MsgBox MyQueryBackJob.SubmitTime**
TargetStart	Date variant: Indicates the time at which the user requested that the QueryBack job begin processing, as specified in one of the Submit method's arguments. Differences between the value of this property and that of the StartTime property depend on the length of the job queue. **MsgBox MyQuery.TargetStart**

Related Numeric Constants

Table 8-28 on page 8-74 explains the significance of the three numeric values possible for the QueryBackJob object's Status property, listing the constant names for these values as found in the MetaCons.bas file in your MetaCube directory.

***Table 8-28** QueryBackJob Class of Objects: Status Constants*

Job Status	MetaCons.bas Constant Name	Constant
Pending	QueryBackJobStatusPending	0
Executing	QueryBackJobStatusRunning	1
Completed	QueryBackJobStatusFinished	2

QueryBackJob Methods

Table 8-29 summarizes the methods of the QueryBackJob class of objects.

Table 8-29 *QueryBackJob Class of Objects: Methods*

Method	**Description/Example**
DeleteJob	Deletes a pending or completed job from the queue. Deleting a recurring job prevents that job from spawning a new incarnation of itself for the following, day, month, or year. When applied to a completed QueryBackJob, this method deletes whatever tables store their results. **MyQueryBackJob.DeleteJob**
RefreshStatus	Retrieves and refreshes values of the QueryBackJob object's properties. Before performing any operation on an existing QueryBackJob, you must deploy this method. You can also deploy this method on an entire collection of QueryBackJob objects: **MyMetabase.QueryBackJob.RefreshStatus**
Retrieve	This method retrieves from the database the result of a QueryBack job, returning a Query object and, if the Scratch property was set to false prior to submission, any children of that object that existed when the query was submitted. **Set MyQuery = MyQueryBackJob.Retrieve** For an example of an application that submits a query to QueryBack and retrieves the result, see MetaCube API Exercise 21 on page 8-15.

QueryBackJob Collections

Table 8-30 summarizes the methods available for QueryBackJob collections:

Table 8-30 *QueryBackJob Class of Objects: Collections*

Collection	Description
RefreshStatus	Retrieves and refreshes the values returned by all properties for all QueryBackJob objects in a collection. **MyMetabase.QueryBackJobs.RefreshStatus**
ItemJobID	Object: the unique identification number that the scheduling daemon assigns to each QueryBackJob object when the job is submitted. This number is the index into the QueryBackJobs collection. **MyMetabase.QueryBackJobs.ItemJobID**

Chapter

9

The Schema Class of Objects and Its Collections

This brief chapter introduces the Schema class of objects and its hierarchy of Table and Column collections. All three object classes feature a Name property by which you can view the names of the schemas / table owners, tables, and columns in the relational database. MetaCube Warehouse Manager invokes these objects to populate the Physical Object Map, a view of schemas / table owners, tables, and columns in the database.

This entire class of objects and its descendants are provided for your reference when creating the metadata-map of the physical structures within the relational database. MetaCube creates the collections of Schema, Table, and Column objects by reviewing the database system tables. You thus cannot instantiate an object within any of these collections except indirectly, by creating a new table owner, a table, or a column in the relational database. You also cannot change the properties of these objects, as they are read-only.

Schemas, Tables, Columns

The Schema class of objects features only a single property, Name, which stores the string name of a schema / table owner in the relational database. Within the collection of Schema objects, there is a Schema object for each schema / table owner in the database's system tables. Each Schema object owns a collection of Table objects identifying the tables within that schema / table owner.

Like the Schema object class, the Table class of objects features only a single property, the Name property, which identifies the name of the table that the object represents. Each table so identified stores a set of columns, described by the Table object's collection of Column objects.

The Column object features two properties: the Name property, which identifies the name of a column in the table owning that Column object, and the Type property, which indicates the type of data stored in the column. The Type property identifies different column types by an integer code, summarized in Table 9-1.

Table 9-1 *Column Type Constants*

Column Type	MetaCons.bas Constant Name	Constant
Character or Variable Character	DataTypeCharacter	0
Numeric	DataTypeNumeric	1
Date	DataTypeDate	2
Other	DataTypeUnsupported	3

Chapter

10

The User and DSSSystem Classes of Objects

This chapter introduces the Users class of objects, the DSSSystems class of objects, and the AvailableDSSSystems class of objects, a child of the Users class.

In MetaCube Secure Warehouse, an administrator manages access to data by assigning DSS Systems to users or users to DSS Systems. The administrator can further restrict the availability of data by assigning mandatory filters to a user of a DSS System. By defining a users's properties in Secure Warehouse, the administrator specifies how that user can interact with an Informix database. All of these Secure Warehouse procedures are accomplished by manipulating the Users, DSSSystems and AvailableDSSSystems classes of objects.

The DSSSystem Class of Objects

The DSSSystem class of objects is used in MetaCube Secure Warehouse to represent DSSSystems that are available in metadata for a particular database connection. In Secure Warehouse, the DSSSystems listed in the DSSSystems tree correspond to the member objects of a DSSSystems collection.

You cannot deploy an Add method to instantiate a DSSSystem object. Instead, after MetaCube connects to the database, the DSSSystems collection is populated with DSSSystem objects defined in metadata. To create a new DSSSystem object, use Metabase.CreateNew, as described in "Metabase Methods" on page 3-11.

There are few manipulations you can perform on a DSSSystem object; the class has only two properties and no methods.

DSSSystem Properties

Table 10-1 describes the two properties available for the DSSSystem class of objects.

Table 10-1 *DSSSystem Class of Objects: Properties*

Property	Description/Example
LastUpdate	Stores as a variant the date and time the DSS System's metadata was last updated. **MsgBox MyDSSSystem.LastUpdate**
Name	A string that identifies the name of the DSS System. **MyDSSystem.Name = "Finance Demo"**

DSSSystem Collections

In Secure Warehouse, the DSSSystems collection represents all of the DSSSystems available for a particular database connection. Although the DSSSystems collection of objects has no Add method, it does provide all the other standard methods available for manipulating MetaCube collections, such as **MakeFirst**, **MakeNth**, and **Remove** (see Table 1-1 on page 1-7). It also includes the standard properties **Count** and **Names** (see "Object Class Hierarchies and Collections" on page 1-6).

The User Class of Objects

The User class of objects supports the actions a data warehouse administrator would perform while using Secure Warehouse, such as assigning DSS Systems and mandatory filters to users and defining user properties. In Secure Warehouse, the Users listed in the Users tree correspond to the member objects of a Users collection. To manipulate users, you must be a secure user—that is, the data warehouse administrator must use MetaCube Secure Warehouse to grant you access to Secure Warehouse and Warehouse Manager.

Instantiating a User Object

To instantiate a User object, add a new instance of the User class of objects to a Metabase object's collection of users:

```
    MyMetabase.Users.Add "User1"
```

When instantiating a user, you must include the name of the user as an argument. To call the **Add** method, a user must be granted access to Secure Warehouse (that is, the property User.SecureUser must be set to true).

User Properties

A User object combines three categories of information: DSS Systems available to this user (represented by the AvailableDSSSystems collection, which is a child of the User object), mandatory filters (assigned using methods available in the User class), and user properties.

The properties of a User object control how a user interacts with an Informix database. For example, one property defines the PDQ Priority to use while processing a user's queries. Table 10-2 summarizes the properties of the User class of objects.

Table 10-2 *User Class of Objects: Properties*

Property	Description/Example
AuditUser	Boolean. A true value indicates that MetaCube will record information about queries run by the user. This information can be used to tune system performance. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.AuditUser = True**
ConnectString	String: Identifies the ODBC data source; defaults to the value of Metabase.ConnectString. **MyUser.ConnectString = "MetaDemo"**

Table 10-2 *User Class of Objects: Properties*

Property	Description/Example
DataSkip	Long: Determines whether an Informix RDBMS can skip locked or otherwise unavailable rows when attempting to retrieve data for the user. Table 3-5 on page 3-15 identifies the possible constants for this property. DataSkip is enabled or disabled when the user connects to MetaCube and an Informix RDBMS. Defaults to the server setting. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.DataSkip = DataSkipOff** For more information, see the DATASKIP entry in the *Informix Guide to SQL: Syntax*.
DefaultDSS	String: Identifies the name of the default DSS System for the user. The default value for this property is null. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.DefaultDSS = "Finances"**
ForeignUser	Boolean. A true value for this read-only property indicates the current user exists in the client table for the current database connection and an entry for the current user exists in the MetaCube registry, but the ConnectString information for the user, as stored in the registry, does not match the connect string used for the current database connection. **MyUser.ForeignUser = True**
MandatoryQB	Boolean. A true value indicates that this user cannot run queries in real time and must generate QueryBack jobs. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.MandatoryQB = True**

Table 10-2 *User Class of Objects: Properties*

Property	Description/Example
MaxTotal-Fetches	Long: A number greater than zero that determines the maximum number of rows that MetaCube will retrieve for a single SQL statement. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.MaxTotalFetches = 200**
MetaSchema	String: The prefix applied to MetaCube metadata tables to ensure their uniqueness in the RDBMS; defaults to the value of Metabase.MetaSchema. **MyUser.MetaSchema = "MetaCube."**
Name	String: The name of the User object, specified as an argument upon instantiation. This name should be unique within a Users collection, and its uniqueness will be enforced when you use the User.Save method. **MyUser.Name = "New Name"**
PDQPriority	Long: An integer from -1 to 100. This property designates the Parallel Data Query (PDQ) Priority of the users's decision support system queries submitted by MetaCube to the Informix database. PDQ Priorities determine the extent to which the Informix database executes a user's queries in parallel. A value of 0 explicitly precludes any parallel operations, a value of one enables only parallel scans, and values between two and 100 represent the percent of available system resources that queries against this decision support system can consume. In multi-processor systems, high PDQ Priorities enable the database to process queries faster. The value of this property defaults to -1, indicating that MetaCube will not set PDQ Priority for a user. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.PDQPriority = 50** For more information about PDQPriority, see the *INFORMIX-OnLine Dynamic Server Administrator's Guide.*

***Table 10-2** User Class of Objects: Properties*

Property	Description/Example
QBPriority	Long: The priority to be assigned to QueryBack jobs submitted by the user. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.QBPriority = 3**
QBSpace	String: The dbspace to be used for objects created for the user. An empty string indicates that the default dbspace should be used. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.QBSpace = ""**
QueryBack-Times	String: Identifies the hours when this user's QueryBack jobs can execute. The string consists of triplets, that is, multiples of three numbers: ■ The first number specifies the day of the week. Possibilities range from 1 to 7, where 1 = Monday and 7= Sunday. ■ The second number specifies the start time, as measured in seconds (0 to 86,399) ■ The third number specifies the stop time, also measured in seconds (0 to 86,399) The numbers within each triplet are delimited by slashes. The triplets themselves are delimited by backslashes. For example, 1/0/86399\2/0/86399 consists of two triplets that allow the user to execute QueryBack jobs all day on Monday and Tuesday. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.QueryBackTimes = "1/0/86399\2/0/86399"**
QueryBack-TimesCount	A read-only property provided to help client applications parse the QueryBackTimes string. **MgsBox MyUser.QueryBackTimesCount**

Table 10-2 *User Class of Objects: Properties*

Property	Description/Example
Role	String: The name of the Informix role that will be assigned to the user. An empty string indicates that no role will be assigned. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.Role =** ""
SecureUser	Boolean. A true value indicates this user is authorized to access Secure Warehouse and MetaCube Warehouse Manager. The default value is false. During upgrades from previous MetaCube versions, the user "metapub" is always set to true. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.SecureUser = True**
SlowQuery-Warning	Long: An integer greater than zero that defines the threshold for issuing a slow query warning. MetaCube Explorer displays a slow query warning when a user submits a query with a processing cost greater than this threshold value. Processing costs are based on values that the data warehouse administrator assigns to metadata tables. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.SlowQueryWarning = 10000**
UserSetPDQ	Boolean. A true value indicates that the user can set his or her own PDQ Priority in a client application. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.UserSetPDQ = True**

User Methods

Table 10-3 summarizes the methods of the User class of objects.

Table 10-3 *User Class of Objects: Methods*

Method	Description/Example
AddMandatory-Filter	Adds a mandatory filter to the collection of filters owned by the user. The method requires two arguments: a string providing the full path to the filter and a string providing the owner of the filter. The owner should always be metapub. The full path to a filter is obtained by deploying Filter.FullPathName. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.AddMandatoryFilter _** **"\Mandatory\Time\LastYear", "metapub"**
Delete	Deletes a user from the RDBMS metadata and deletes that user's entry from the MetaCube engine's registry. Only users who have been granted access to Secure Warehouse (meaning the property User.SecureUser is set to true) can call this method. **MyUser.Delete**
Mandatory-FilterNames	Retrieves a ValueList of the names and paths of mandatory filters. The method takes one argument: the DSS System object for which filters should be retrieved. **MsgBox MyUser.MandatoryFilterNames MyDSSSystem**
Mandatory-FilterOwners	Retrieves a ValueList of the owners of mandatory filters. The method takes one argument: the DSS System object for which filters should be retrieved. Each item in the ValueList corresponds to an item in the ValueList generated by MandatoryFilterNames. The order of both lists is identical and cannot be changed. **MsgBox MyUser.MandatoryFilterOwners MyDSSSystem**

Table 10-3 *User Class of Objects: Methods*

Method	Description/Example
Remove-MandatoryFilter	Removes a mandatory filter from the collection of mandatory filters owned by this user. This method *does not* remove this filter from the RDBMS metadata. The method requires two arguments: a string providing the full path to the filter and a string providing the owner of the filter. The full path to a filter is obtained by deploying Filter.FullPathName. Only users who have been granted access to Secure Warehouse (that is, the property User.SecureUser is set to true) can call this method. **MyUser.RemoveMandatoryFilter _** "**\Mandatory\Time\LastYear**", "**metapub**"
Save	Saves the user to the RDBMS metadata. Only users who have been granted access to Secure Warehouse (meaning the property User.SecureUser is set to true) can call this method. **MyUser.Save**

User Collections

In Secure Warehouse, the Users collection represents all of the users with entries in the MetaCube registry. Typically, this corresponds to all the users who are being managed with Secure Warehouse. The Users collection provides all the standard methods available for manipulating MetaCube collections, such as **MakeFirst**, **MakeNth**, and **Remove** (see Table 1-1 on page 1-7), and it also includes the standard properties **Count** and **Names** (see "Object Class Hierarchies and Collections" on page 1-6). In addition to the standard methods and properties available to all collections, the Users collection provides the methods summarized in Table 10-4.

Note that to call the **Remove** method, a user must be granted access to Secure Warehouse (that is, the property User.SecureUser must be set to true).

Table 10-4 *Users Class of Objects: Methods*

Method	Description/Example
LoadUsers	Loads all user information contained in the metadata client table; typically used for Secure Warehouse only. No standard MetaCube applications except Secure Warehouse need the user information stored in the client table, so to improve performance, the MetaCube analysis engine normally does not load that information into memory. Custom-built applications, however, may require the user information available in the client table. Note that all user information stored in the registry of the MetaCube analysis engine is always available, and that information is sufficient to display a list of users in Secure Warehouse. To access user properties, however, the LoadUser method must be deployed. **MyUsers.LoadUsers**
PurgeRegistry	Removes user entries from the MetaCube registry. This method is used to clean up the registry when a DSS System or database connection is no longer used. Which user entries are actually removed by this method depends on this method's one argument, a string that contains the connect string for a database connection. Based on that string, MetaCube will do either of the following: ■ If the connect string does not match the connect string for the current connection, MetaCube will purge from its registry all user entries containing the specified connect string. ■ If the connect string does match the connect string for the current connection, MetaCube will purge from its registry all entries for users who do not have an entry in the Client table but who do have a connect string that matches the specified connect string. Only users who have been granted access to Secure Warehouse (meaning the property User.SecureUser is set to true) can call this method. **MyUsers.PurgeRegistry "MetaCube Demo"**

Table 10-4 *Users Class of Objects: Methods*

Method	**Description/Example**
SynchRegistry	Adds users to the MetaCube registry in bulk. When called, this method adds entries to the registry for all users who exist in the Client table for the current database connection but do not have an entry in the registry. Once a user has a registry entry, that user is displayed in MetaCube Secure Warehouse and can connect to a database using Web Explorer. Only users who have been granted access to Secure Warehouse (meaning the property User.SecureUser is set to true) can call this method. **MyUsers.SynchRegistry**

The AvailableDSSSystems Class of Objects

Each AvailableDSSSystem class of objects is a child of a User object. An AvailableDSSSystems object is a collection representing the DSSSystems that a particular user can access. The members of an AvailableDSSSystems collection are actually pointers to objects in the DSSSystems collection that is owned by the Metabase object. (For more information, see "The DSSSystem Class of Objects" on page 10-3.) In Secure Warehouse, the AvailableDSSSystems collection represents all of the DSSSystems that have been assigned to a user, thus granting that user access to those DSS Systems.

Instantiating an AvailableDSSSystem Object

To instantiate an AvailableDSSSystems object, add an instance of the AvailableDSSSystems class of objects to a User object:

```
MyMetabase.User.AvailableDSSSystems.Add MyDSSSystems
```

When instantiating an AvailableDSSSystems object, you must provide a DSSSystems object as an argument.

AvailableDSSSystem Properties and Methods

The AvailableDSSSystems collection provides all the standard methods available for manipulating MetaCube collections, such as **MakeFirst**, **MakeNth**, and **Remove** (see Table 1-1 on page 1-7), and it also includes the standard properties **Count** and **Names** (see “Object Class Hierarchies and Collections” on page 1-6).

Chapter

11

The SystemMessage Class of Objects

This very brief chapter introduces the SystemMessage class of objects, which allows you to distribute messages to all users within a DSS System. MetaCube Agent Administrator, MetaCube's client-side tool for database administrators, enables administrators to create messages that users can view through Explorer's interface. Both applications either get or set properties of the SystemMessage object.

The SystemMessage Class of Objects

To distribute a new message throughout the MetaCube family of applications, you must instantiate a new SystemMessage object. To instantiate a SystemMessage object, you must enter the message itself as the first argument and the date and time as the second. The CurrentTime property of the Metabase object can furnish the latter argument:

```
MyMetabase.SystemMessages.Add _
    "The Data Warehouse is operational!", _
        MyMetabase.CurrentTime
```

Note that you need not specify the name of the SystemMessage object, as this class of objects does not feature a Name property. If you find it necessary to identify a particular SystemMessage object, do so by index number. Aside from the standard **Parent** property, the string text of the message and its date are the only properties of the SystemMessage object, as explained in Table 11-1 on page 11-4.

Table 11-1 *SystemMessage Class of Objects: Properties*

Property	Description/Example
LastUpdate	Date variant: The time and date of the message. **MySystemMessage = MyMetabase.CurrentTime**
Message	String: The text of the message. Default property. **MySystemMessage.Message = "Up and running"**
Parent	The Metabase object. The scope of a message is limited to a DSS System. **MsgBox MySystemMessage.Parent.Name**

The SystemMessage object features no methods and owns no collections.

Chapter

12

The ValueList

This chapter introduces the ValueList.

The ValueList

To return multiple values into different development environments, MetaCube allows you to specify the format in which to return those values. Any property which stores a set of values as a ValueList can include an additional term in its syntax indicating that the values should be stored as an array or a tab-delimited string. In addition, you can specify a subset of the values in the ValueList, the maximum number of values to return, or the order in which to return them.

The objects that return a ValueList and the properties of those objects are:

- Dimension.AttributeNames
- Attribute.ValueList
- FactTable.MeasureNames
- MetaCube.FormatStrings
- Extension.Arguments
- Extension.ArgumentTypes
- Extension.Functions
- Extension.Types
- MetaCube.PageLabels
- All objects' VerifyResults properties

Table 12-1 summarizes the commands that can be appended to a statement returning a ValueList. Note that three of the five commands apply to only the actual ValueList property of the Attribute object. The remaining commands, or specifications, are illustrated with an example involving an instantiation of the Dimension class of objects, as represented by an object variable named MyDimension, and that object's AttributeNames property. You can substitute any of the objects and their respective properties listed on the previous page.

Table 12-1 *ValueList Specifications*

Specification	Description/Example
ArrayValues	This specification translates the values represented in a ValueList to an array, which can be stored in a variant or array variable in Visual Basic for Applications and in other variable types in other development environments. Visual Basic 3.0 does not support the passing of arrays through object linking and embedding. You can translate the values in any ValueList to an array. **Let VariantVariable = _** **MyDimension.AttributeNames.ArrayValues**
MaxRows	Treat this command as a property of the Attribute object's ValueList property, which represents all the values for the attribute. MaxRows can be set equal to any long value. MaxRows limits the number of values that the ValueList property can return, a function useful for preventing tab-delimited strings from becoming unwieldy. The default is 200. You cannot set a maximum on the values in ValueLists returned by properties other than Attribute object's ValueList property. **Let MyAttribute.ValueList.MaxRows = 2** **MsgBox MyAttribute.ValueList.TabbedValues**
Sort	This command specifies a sort on the values represented in the Attribute object's ValueList property. Set the Sort command equal to a long value or corresponding constant, as specified in Table 8-7 on page 8-23. You cannot sort values in ValueLists represented by any property other than the ValueList property of the Attribute object. **Let MyAttribute.ValueList.Sort = SortDirectionDesc** **MsgBox MyAttribute.ValueList.TabbedValues**

Table 12-1 *ValueList Specifications (continued)*

Specification	**Description/Example**
Subset	This command allows you to use SQL wildcard syntax to specify a subset of the values in an Attribute object's ValueList. You can apply this command only to a ValueList represented by an Attribute object's ValueList property. **Let MyAttribute.ValueList.Subset = "%x%"** **MsgBox MyAttribute.ValueList.TabbedValues** This example only displays values that include the letter "x."
TabbedValues	This specification translates the values represented by a ValueList into a tab-delimited string. If you do not indicate how MetaCube should return the values in a ValueList, MetaCube will, by default, return the values as a tab-delimited string. You can deploy this command on any ValueList, as returned by any of the properties listed above. **Let StringVariable = _** **MyDimension.AttributeNames.TabbedValues** or simply **Let StringVariable = MyDimension.AttributeNames**

Chapter

13

OLE Requirements: the Application Class of Objects and Global Properties

This chapter briefly explains the Application class of objects, the highest-level object class for any OLE software server. For all MetaCube applications this object represents the MetaCube engine. We previously introduced the Metabase class of objects as the parent of all other object classes in MetaCube's hierarchy. For the purposes of application development this will always be the case. However, the OLE standard requires the Application object class, which we include here for the sake of completeness.

This chapter also introduces two properties that apply to all MetaCube object classes.

The Application Class of Objects

Table 13-1 summarizes the properties of the Application class of objects.

Table 13-1 *Application Class of Objects: Properties*

Property	Description/Example
FullName	String: This property returns the file name and location of the MetaCube engine, including the path. Typically, the value of this read-only property will be "c:\metacube\metacube.exe." **MsgBox Application.FullName**
Name	String: This read-only property returns the name of the application, in this case, "MetaCube." This property is the default property of the Application object. **MsgBox Application.Name**
Parent	Object: This property returns the parent of the Application object, which is the Application object itself. This property is required by OLE but is otherwise useless.
Visible	Boolean: Returns false. Required by OLE.

The Application class of objects features no methods and only one collection, the collection of Metabase objects currently active. When deploying properties of the Application object class in Visual Basic for Applications, you will notice that the name of the application returned is Excel, as Excel and MetaCube communicate continuously. In an application compiled as an executable, the Application object will represent the MetaCube engine installed in your computer.

Global Properties: Application and Type

All MetaCube object classes have in common two properties, the **Application** property and the **Type** property. The Application property returns the name of the application, “MetaCube.” The Type property returns the name of the object class of which the object is an instance, such as “Measure” or “DimensionElement.” Both properties are read-only and return strings.

Chapter

14

Scoping Rules

This chapter briefly explains rules for identifying objects that have the same name but belong to a different parent or belong to a different class entirely.

Scoping Rules

To avoid ambiguity when specifying the name of a DimensionElement, Attribute, or Measure object, follow the conventions discussed below.

The DimensionElement Object Class

You can identify a DimensionElement object by name if the name of the DimensionElement object is unique throughout the DSS System. If dimension elements belonging to different dimensions are described by objects of the same name, you can specify the name of the parent Dimension object. If a DimensionElement object and an Attribute object belonging to the same dimension share the same name, you can also indicate that you refer to the DimensionElement object, not the Attribute object. To identify a DimensionElement named “Brand” within the “Product” dimension, three names are possible, listed in order of increasing scope and precision:

```
MyQuery.QueryCategories.Add “Brand”
MyQuery.QueryCategories.Add “Product.Brand”
MyQuery.QueryCategories.Add _
    “DimensionElements.Product.Brand”
```

The Attribute Object Class

You can identify an Attribute object by name if the name of the Attribute object is unique throughout the DSS System. If attributes belonging to different dimensions are described by objects of the same name, you can specify the name of the parent Dimension object. If an Attribute object and a DimensionElement object belonging to the same dimension share the same name, you can also indicate that you refer to the Attribute object, not the DimensionElement object. To identify an Attribute named “Brand” within the “Product” dimension, three names are possible, listed in order of increasing scope and precision:

```
MyQuery.QueryCategories.Add “Brand”
MyQuery.QueryCategories.Add “Product.Brand”
MyQuery.QueryCategories.Add _
    “Attributes.Product.Brand”
```

The Measure Object Class

You can identify a Measure object by name if the name of the Measure object is unique throughout the DSS System. If measures belonging to different fact tables are described by objects of the same name, you can specify the name of the parent FactTable object. If a Measure object and some other object associated with the fact table share the same name, you can also indicate that you refer to an object of the Measure class.

To identify a Measure named “Units Sold” within the “Sales Transaction” fact table, three names are possible, listed in order of increasing scope and precision:

```
MyQuery.QueryItems.Add “Units Sold”
MyQuery.QueryItems.Add _
    “Sales Transactions.Units Sold”
MyQuery.QueryItems.Add _
    “Measures.Sales Transactions.Units Sold”
```

It is good programming practice to scope as precisely as possible. For simplicity's sake, some examples in this text have not been precisely scoped.

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