Database Concepts

8th Edition

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Online Appendix G

Getting Started with Microsoft Visio 2016

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Appendix Objective

- Learn how to create E-R data models in Microsoft Visio 2016

What Is the Purpose of This Appendix?

Microsoft Visio 2016 is a component of Microsoft Office 2016, and is widely used to produce a variety of diagrams. There are three versions of Microsoft Visio 2016: : Visio Standard 2016, Visio Professional 2016, and Visio Pro for Office 365. You can see a comparison chart for these versions at https://products.office.com/en-us/visio/microsoft-visio-2013-plans-and-pricing-compare-visio-options. Note that the "2013" in the URL is correct—this is probably an error on Microsoft's part, and may be corrected at some time in the future.

The templates that we use in this appendix are available in all editions.[1] In this appendix, we are primarily interested in Microsoft Visio's ability to create data models.

Why Should I Learn to Use Microsoft Visio 2016?

For the purposes of this book, the most important reason to learn to use Microsoft Visio is that it provides a convenient method of creating the data models discussed in Chapter 5. Unfortunately, Microsoft Visio data models do not provide true linking between entities. Nonetheless, if you have Microsoft Visio 2016 Professional, you will have a tool capable of producing the data models required in the solutions to Review Questions and Exercises in Chapter 4.

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[1] Students registered in CS or MIS classes should check to see if your school is part of the Microsoft Imagine program (https://imagine.microsoft.com/en-us). If so, you may be able to obtain Microsoft Visio 2016 Professional through that program.

What Will This Appendix Teach Me?

As its title implies, this appendix is designed to get you started using Microsoft Visio 2016 to create data models so that you have a tool to create these diagrams.

What Won't This Appendix Teach Me?

The material in this appendix does not go beyond what is necessary to get you started using Microsoft Visio 2016 on the topics covered in *Database Cocepts* (8th edition) [hereinafter referred to as **DBC**]. There are many important Microsoft Visio topics not covered here, including organization charts, project management diagrams (such as Gantt charts and Pert charts), network diagrams (such as Active Directory tree), and Web site maps.

How Do I Start Microsoft Visio 2016?

In this appendix, we are using Microsoft Windows 10 Anniversary Update (version 1607) as our operating system. In this update, Microsoft revised the start menu significantly, and there may be some slight variance between what we describe here and what you see if you are running an earlier version of Windows 10 (although we actually suggest that if you haven't installed the Microsoft Windows 10 Anniversary Update (version 1607), you should do so[2]). To start Microsoft Visio 2016 running in Microsoft Windows 10 , click the Windows Start button, and then scroll down the application menu to the **Visio 2016** icon and then click the icon. We suggest that when you find the Visio 2016 icon, you right-click the icon to bring up a shortcut menu and use the **More | Pin to taskbar** command to place the Visio 2016 icon on the Taskbar for easier access. The Microsoft Visio 2016 splash screen is displayed, followed by the Microsoft Visio 2016 window with the Home page displayed, as shown in Figure G-1.

Microsoft Visio 2016 uses the Microsoft Office Fluent user interface found in most (but not all) Microsoft Office 2007, Office 2010, Office 2013, and Office 2016 products. Here we note that Microsoft Visio 2016 opens with a variant of the New command tab and associated page of the **Backstage view** displayed (the Backstage view is displayed when the **File command tab** is selected).

How Do I Create a Database Model Diagram in Microsoft Visio 2016?

To open a template for data models, click the **Catagories** tab, and scroll to the **Software and Database** templates, as shown in Figure G-2. Click the Software and Database templates icon to display the templates in this category, as shown in Figure G-3. These templates include the template we want to use—the **Crow's Foot Database Notation** template. Click the template to select it. The Crow's Foot Database Notation is the one that Microsoft Visio 2016 uses for data models with the IE Crow's Foot notation as used in Chapter 4. Note that the name *Database Notation* is somewhat misleading, as we are creating data models using E-R diagrams as we understand them from our discussion in Chapter 4. Nonetheless, this is the template we want, and we will have to sort things out as we go along. Also note

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[2] For more information on Microsoft Windows 10 Anniversary Update (version 1607), see https://blogs.windows.com/windowsexperience/2016/08/02/how-to-get-the-windows-10-anniversary-update/#I9eVoQ6fyzus0RLq.97.

that there are templates available for use with IDEF1X notation and for use with UML notation.[3] We briefly mentioned both the IDEF1X and UML notations in Chapter 4, but we are using IE Crow's Foot notation as our standard in this book. Again, we will just have to sort things out as we go along. Click the **Create** button to create a new Database Model Diagram document, as displayed in Figure G-4.

As shown in Figure G-4, a new, blank diagram document, named Drawing1, is created and the appropriate Shapes stencils (a **stencil** is Microsoft Visio 2016's term for a group of template objects) are displayed in the Shapes window. Figure G-5 shows more detail of the Shapes window, including:

- The **Minimize the Shapes window button** — As the name says, use this to minimize the Shapes window.
- The **More Shapes button** — Use this to display the **More Shapes list**, as shown in Figure G-5, if you need to add additional shape templates to the drawing.
- The **Crow's Foot Database Notation button** — Use this to display the Entity Relationship (US units) shapes pane.
- The **Crow's Foot Database Notation stencil** — The set of shape objects in the Entity Relations (US units) stencil.
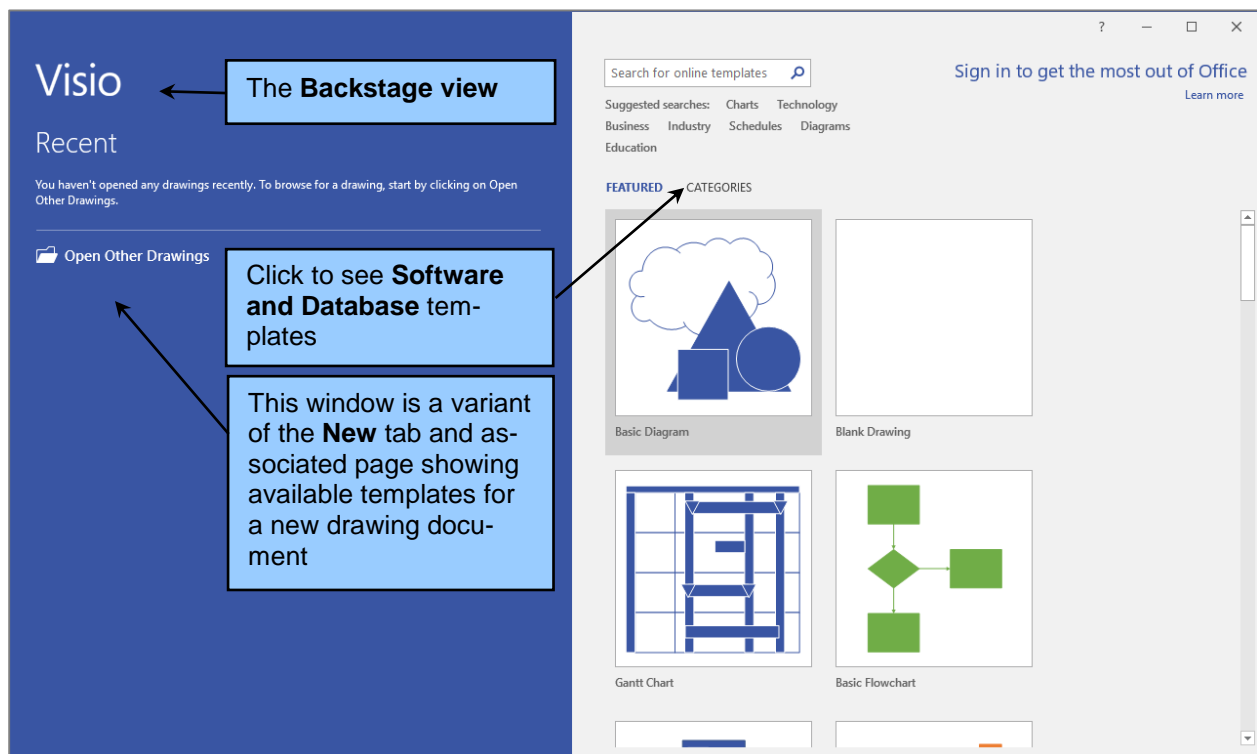
Figure G-1 — The Microsoft Visio 2016 Backstage View

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[3] For more information on these models, see David M. Kroenke and David J. Auer, *Database Processing: Fundamentals, Design, and Implementation*, 14th ed. (Upper Saddle River, NJ: Prentice Hall, 2016), Appendix C (IDEF1X) and Appendix D (UML).

Figure G-2 — The Software and Database Template Category

Figure G-3 — The Crow's Foot Database Notation Template

Figure G-4 — The Microsoft Visio 2016 Data Model Diagram

Figure G-5 — The Shapes Window

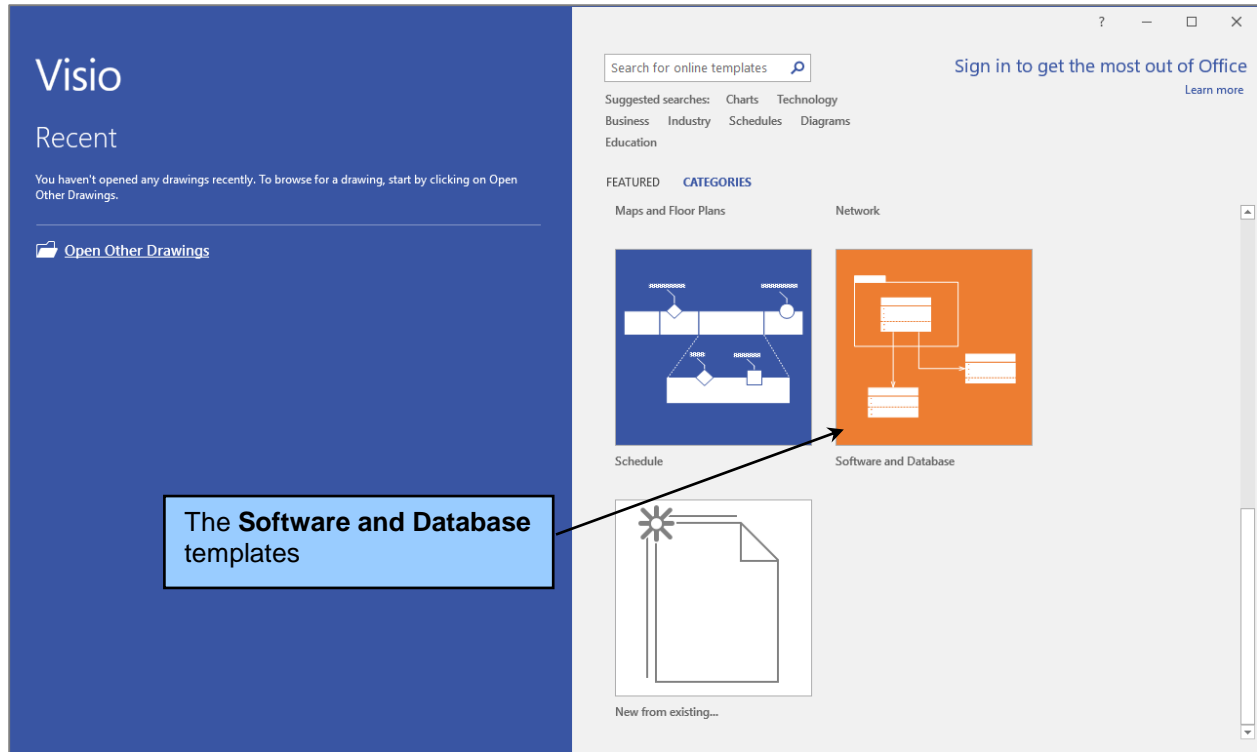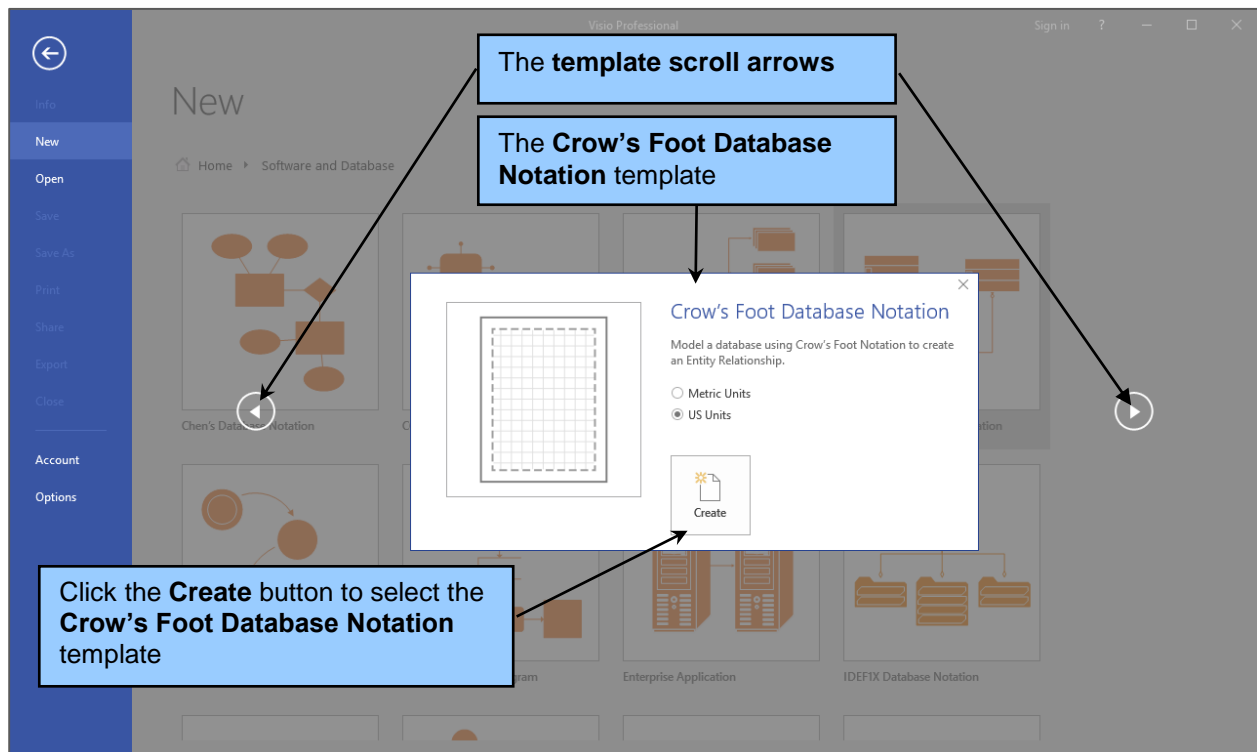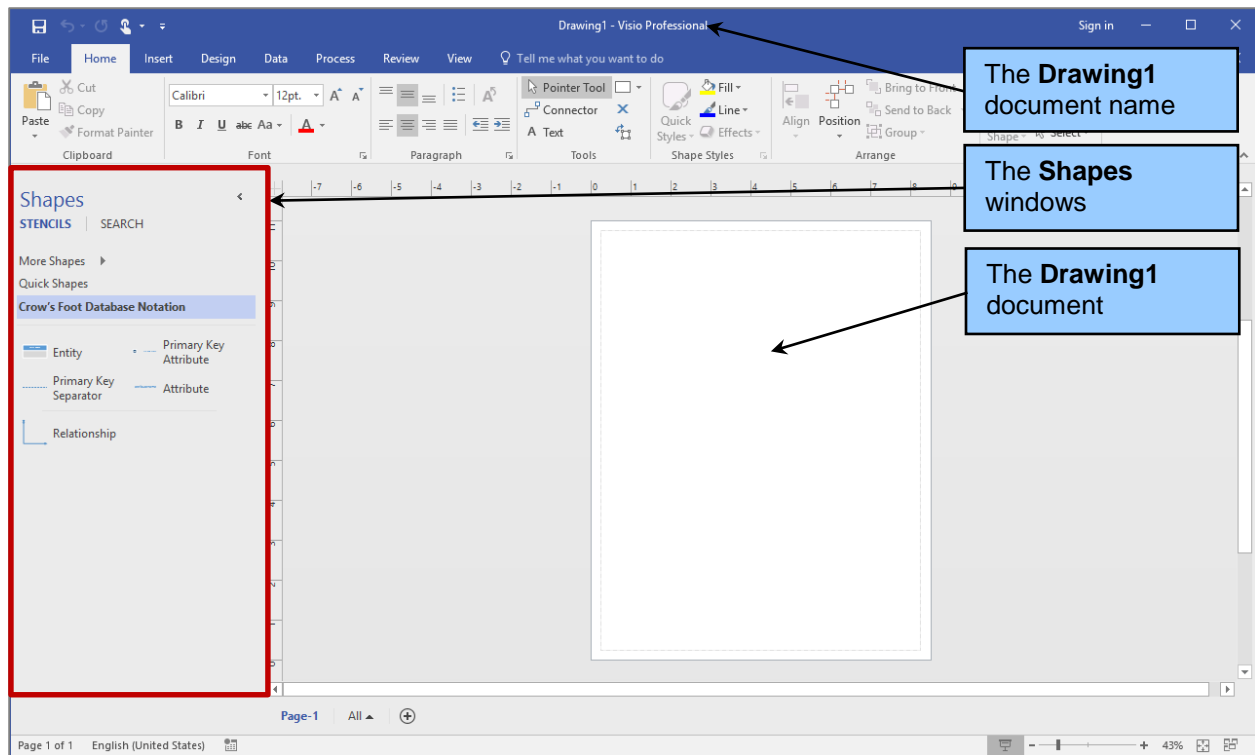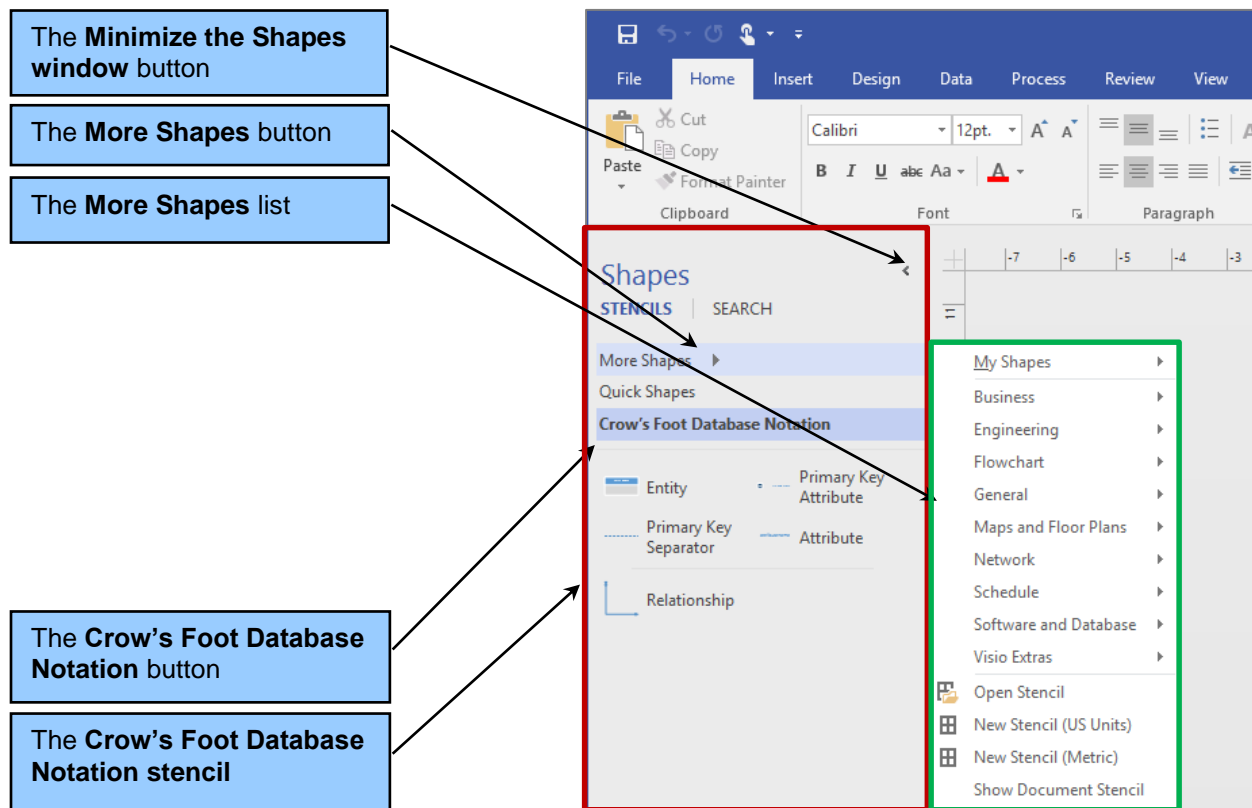Figure G-6 shows the same screen but illustrates what happens when we click on one of the command tabs. Here, we have clicked on the Home tab, and the associated ribbon with the Home tab command groups is displayed. This is how we access commands on the ribbon, but note that when we do this we *may* cover up some of the drawing we are working on.

The Crow's Foot Database Notation stencil contains all the template objects we will use to build our data models. As shown in Figure G-7, it contains:

- The **Entity object** — Use this object to create *entities* for data models in the Microsoft Visio database model diagram.
- The **Relationship object** — Use this object to create relationships between *entities* in *data models* (it is actually what Microsoft usually refers to as a dynamic connector).
- The **Primary Key Attribute object** — Use this object to add additional primary key attributes (as, for example, in composite primary keys) to the *entities* in data models.
- The **Primary Key Separator object** — Use this object to insert a visible line between primary key attributes and non-key attributes in the *entities* in data models.
- The **Attribute object** — Use this object to add additional attributes to *entities* in data models.
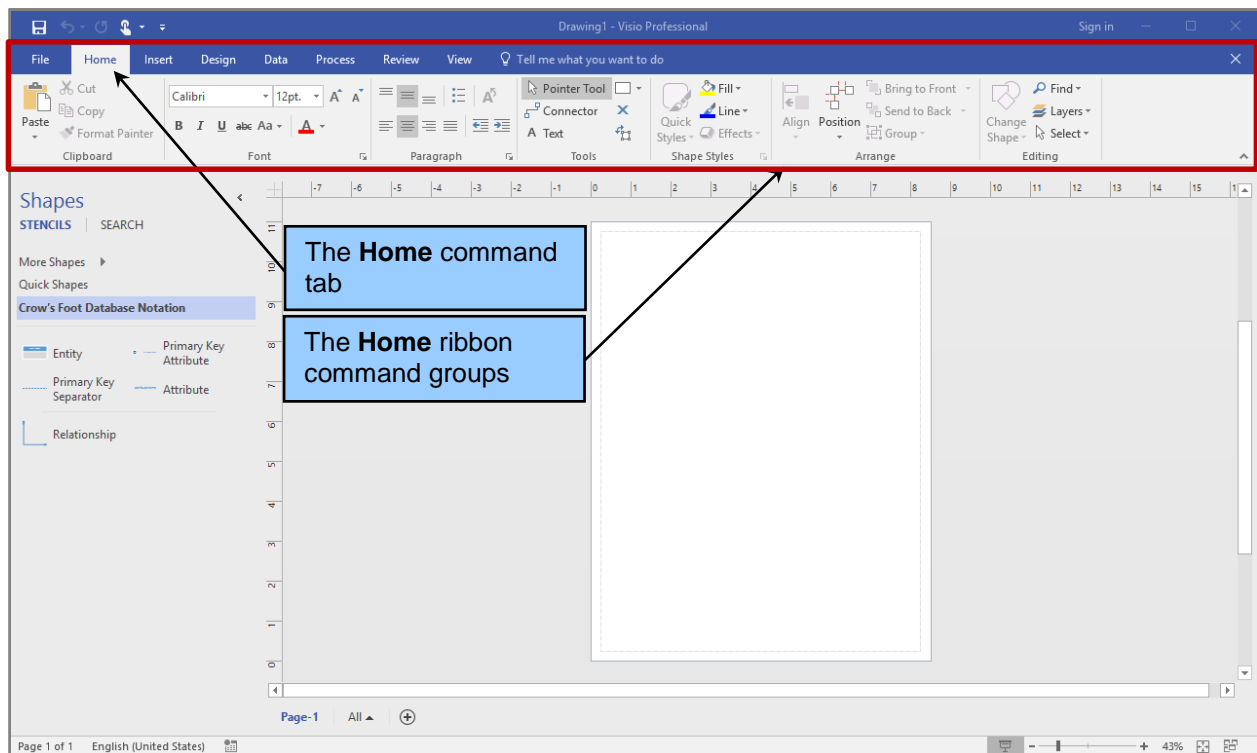

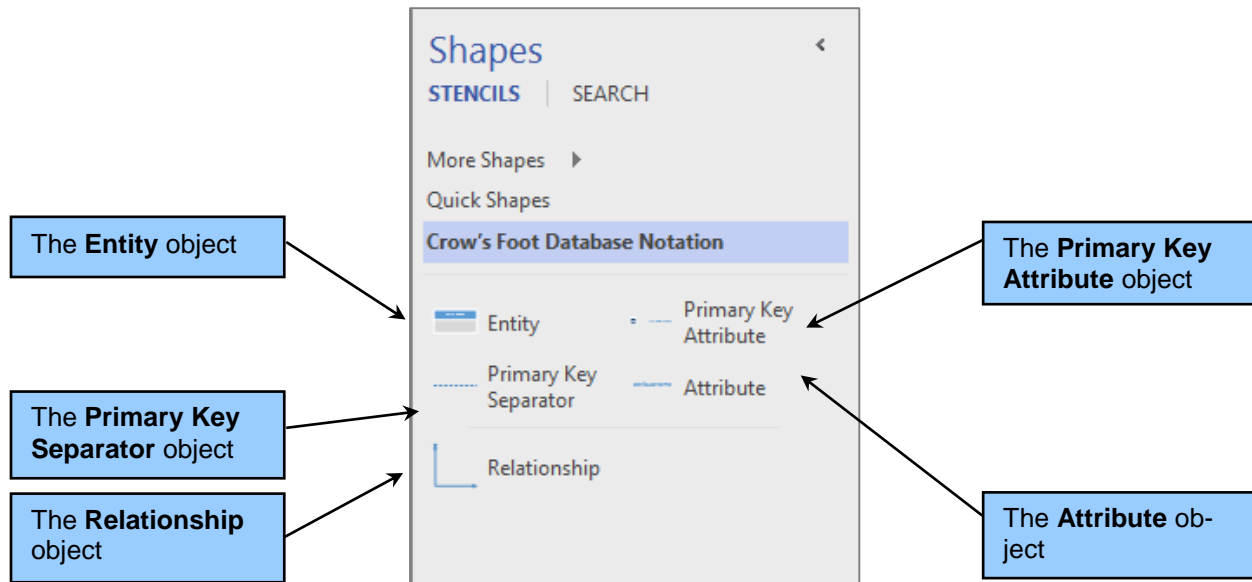**Figure G-6 — The Home Command Tab Ribbon**

Figure G-7 — The Crow's Foot Database Notation (US units) Stencil Objects

Figure G-8 shows the Microsoft Visio 2016 window with:

- The **Ribbon** collapsed and the **Shapes** windows minimized — Note that all of the Crow's Foot Database Notation (US units) stencil objects are still visible. Clicking a command tab will display the ribbon.
- The **Expand the Shapes window** button — Use this to restore the Shapes window to its full size.
- The **Quick Access Toolbar** —The Quick Access Toolbar with buttons are displayed on it.
- The **Zoom** controls — Use these to control the displayed size of the drawing, now shown at 51%.

By configuring the Microsoft Visio 2016 window in this manner, we have a much more efficient working area.

How Do I Name and Save a Database Model Diagram in Microsoft Visio 2016?

We will illustrate creating data models and database designs in Microsoft Visio 2016 by creating an E-R diagram for the Wedgewood Pacific (WP) database that we created in Microsoft Access as part of the Access Workbench Exercises in Chapters 1 and 2 and in SQL Server 2016 in Chapter 3.[4]

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[4] Of course, it could be argued that we really should have created the database design first and then implemented that design. In many database courses, the data modeling and database design topics (which we cover in Chapters 4 and 5) are taught before using SQL to create the databases (which we cover in Chapter 3). In this case, the database design will precede the actual implementation of the database in the DBMS. We prefer to introduce SQL queries earlier. There are two reasons for this. First, users who are never involved in creating databases still often use SQL or QBE for querying databases (usually data warehouses or data marts as discussed in Chapter 8 and Appendix J) to gather information. Second, we like to get our students involved with DBMSs, databases, and SQL as early in the course as possible. Either approach works, and your professor will choose the one that he or she likes best.
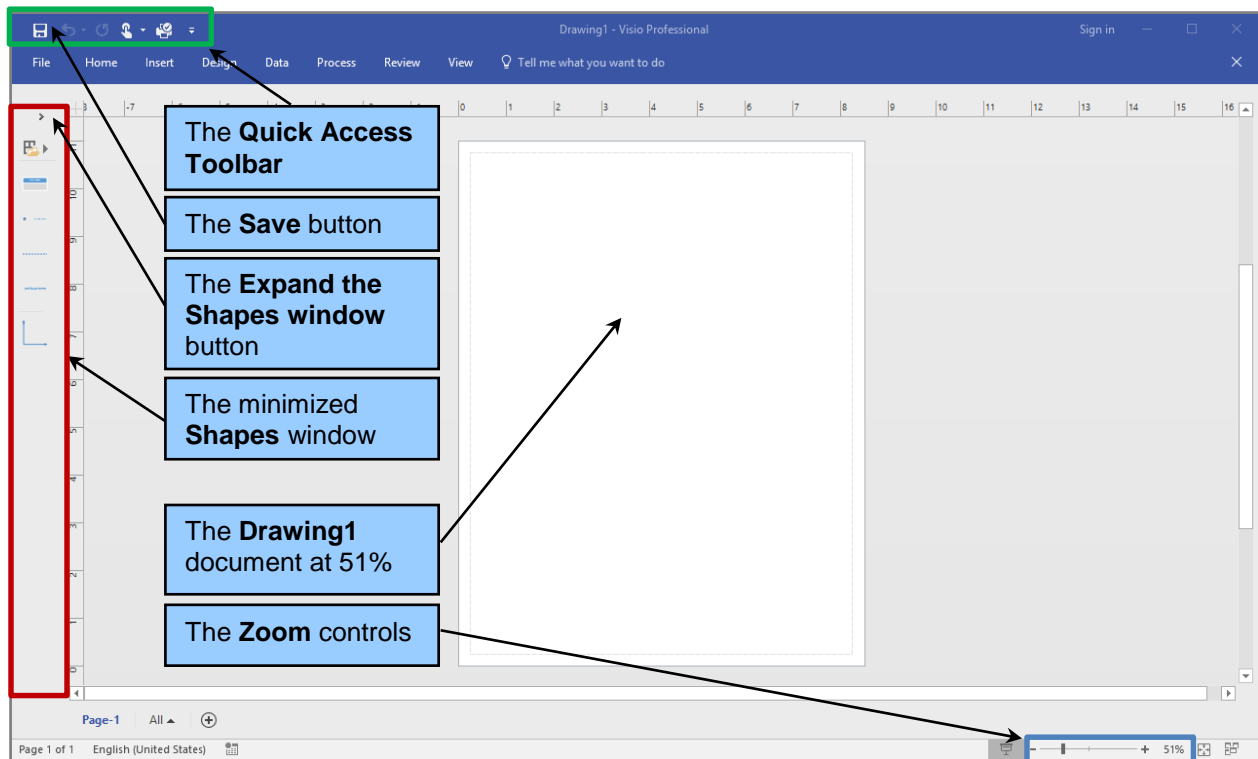
Figure G-8 — The Microsoft Visio 2016 Database Model Diagram with Minimized Shapes Window

The column characteristics for each of the the WP tables are shown in Figure G-9.

To save a Microsoft Visio 2016 database model diagram drawing, click the Save button in the Quick Access Toolbar. The first time we save the drawing, Microsoft Visio 2016 opens a **Save As** dialog box. This is a standard Microsoft Office 2016 dialog box. Name the drawing **WP-Data-Model**.

As we discuss in Chapters 4 and 5, one of the main differences between a data model and a database design is how N:M relationships are handled. In a data model, N:M relationships exist as N:M non-identifying relationships between two strong entities. In a database design, N:M relationships are

broken into two 1:N identifying relationships between three ID-dependent entities. So, we will build the entities we need and then consider exactly how Microsoft Visio 2016 handles data models.

Also as we discuss in Chapters 4 and 5, the diagrams we are creating are entity-relationship models, and we are using the IE Crow's Foot notation as our standard. We will also see how well Microsoft Visio 2016 supports IE Crow's Foot notation.

How Do I Create Entities in a Database Model Diagram in Microsoft Visio 2016?

Now that we have a blank document to use as an E-R diagram work area available, we can build the E-R diagram itself. We start by adding an entity to the E-R diagram. We will add the DEPARTMENT entity. By looking at the column characteristics of the DEPARTMENT table in Figure G-9, we can see the columns that are used in the DEPARTMENT table.

Column Characteristics for the WP DEPARTMENT Table

Column Name	Type	Key	Required	Remarks
DepartmentName	Short Text (35)	Primary Key	Yes	
BudgetCode	Short Text (30)	No	Yes	
OfficeNumber	Short Text (15)	No	Yes	
DepartmentPhone	Short Text (12)	No	Yes	

Column Characteristics for the WP EMPLOYEE Table

Column Name	Type	Key	Required	Remarks
EmployeeNumber	AutoNumber	Primary Key	Yes	Surrogate Key
FirstName	Short Text (25)	No	Yes	
LastName	Short Text (25)	No	Yes	
Department	Short Text (35)	No	Yes	
Position	Short Text (35)	No	No	
Supervisor	Number	No	No	Long Integer
OfficePhone	Short Text (12)	No	No	
EmailAddress	Short Text (100)	No	Yes	

Column Characteristics for the WP PROJECT Table

Column Name	Type	Key	Required	Remarks
ProjectID	Number	Primary Key	Yes	Long Integer
ProjectName	Short Text (50)	No	Yes	
Department	Short Text (35)	Foreign Key	Yes	
MaxHours	Number	No	Yes	Double, fixed, 2 decimal places
StartDate	Date/Time	No	No	Medium date
EndDate	Date/Time	No	No	Medium date

Column Characteristics for the WP ASSIGNMENT Table

Column Name	Type	Key	Required	Remarks
ProjectID	Number	Primary Key, Foreign Key	Yes	Long Integer
EmployeeNumber	Number	Primary Key, Foreign Key	Yes	Long Integer
HoursWorked	Number	No	No	Double, fixed, 1 decimal places

Figure G-9 — The WP Database Table Column Characteristics

Creating an Entity in the Microsoft Visio E-R Diagram:

1.   In the Shapes window, click-and-hold the **Entity** object shown in Figure G-7.
2.   Move the cursor over the blank E-R diagram area, and then release the left mouse button. A new entity object named Entity Name is created on the E-R diagram, as shown in Figure G-10.
3.   Each line of text in the entity is a formatted text box. To edit the text in a text box, just double-click the text.
4.   Double-click Entity Name to select it, and type in the table name **DEPARTMENT**.
5.   Right-click the text to display the shortcut menu as shown in Figure G-11.
6.   Format the table name DEPARTMENT as centered, 12pt, bold, black text with the default fill color. The final entity name appears as shown in Figure G-12.

Now that the we have named the DEPARTMENT entity, we have to deal with the fact that data models and the entities in them do not have primary keys—they have identifiers. There is no symbol, such as PK for primary key, for an identifier. Therefore, we have to make a choice—either use the PK text boxes for identifiers or not use these boxes at all.

For the sake of simplicity, we will use the PK boxes for our identifiers. This simply cuts down on the work we have to do to create the data models. But as we gain more skill using Visio 2016, we opt for more work and a cleaner and more consistent data model approach.
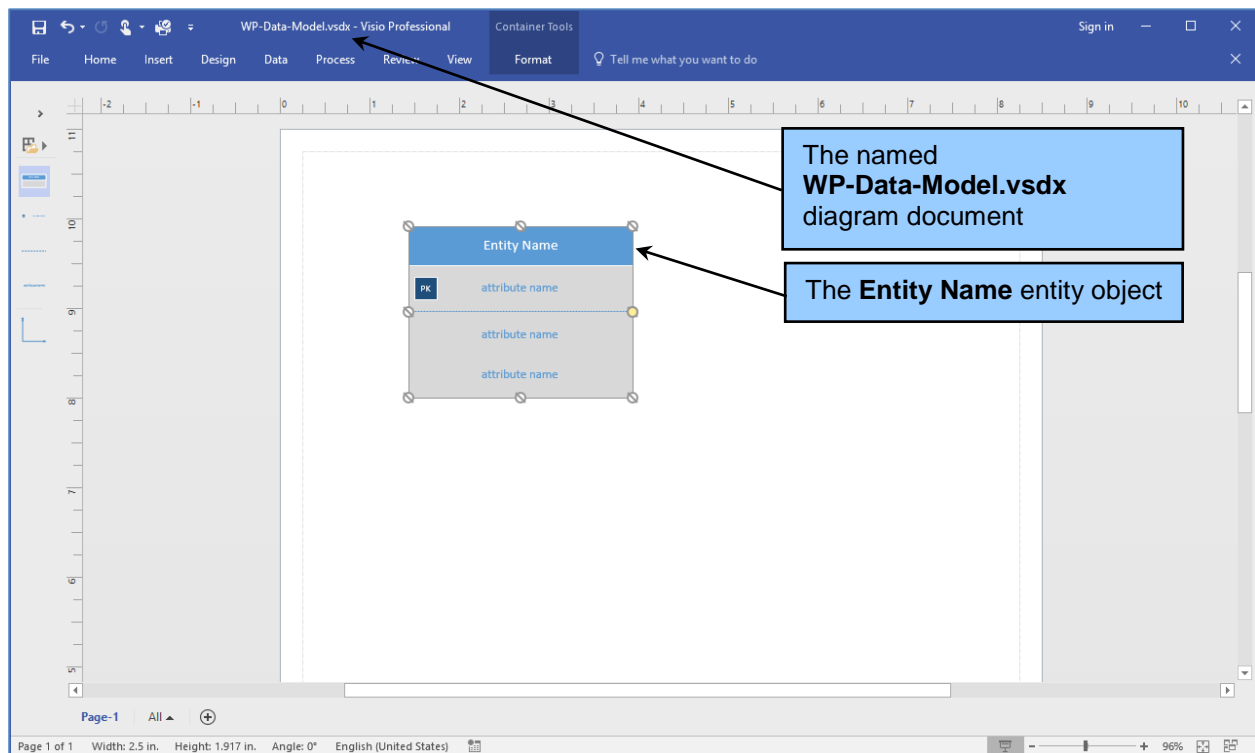

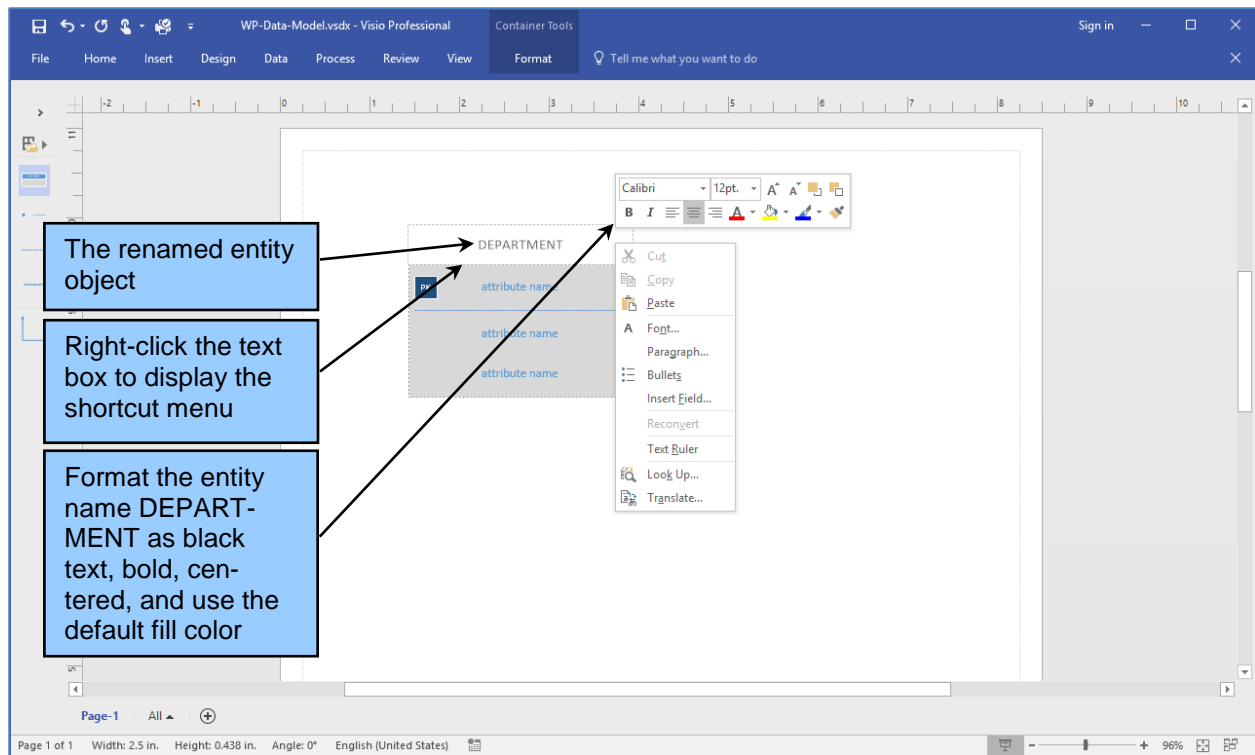**Figure G-10— The Entity Name Entity Object**

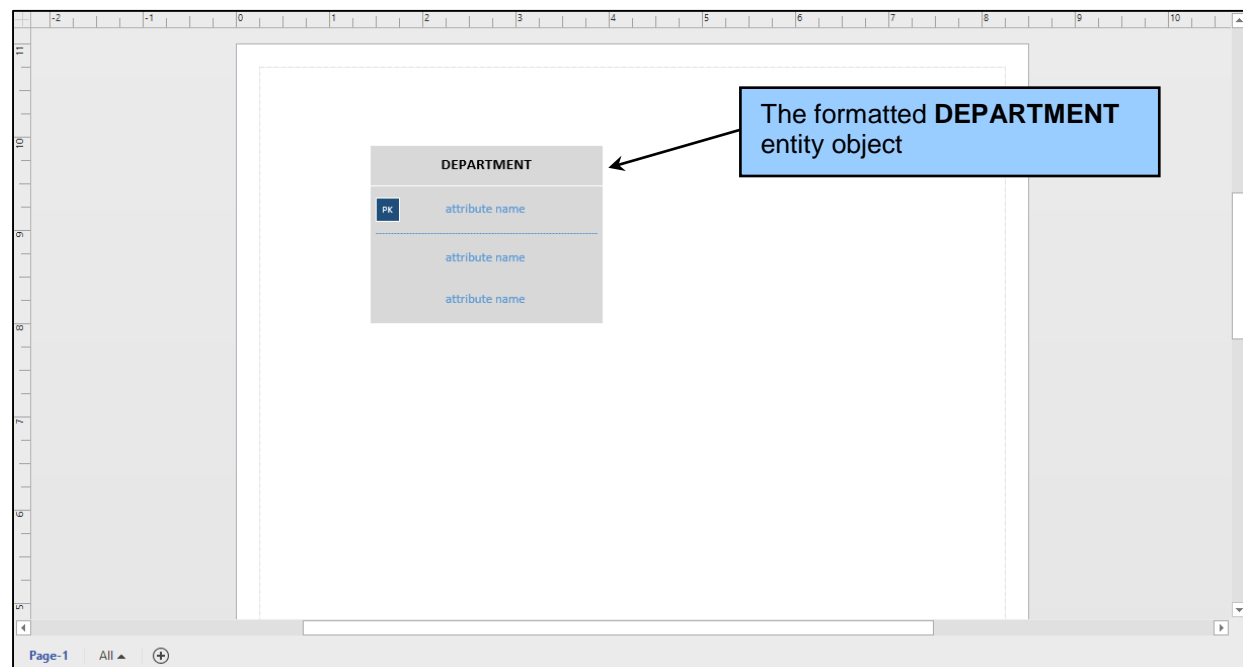**Figure G-11 — Naming and Formatting the Entity**

Figure G-12 — The Named and Formatted DEPARTMENT Entity

Creating the DEPARTMENT Entity Identifier (PK) Attribute in the Visio E-R Diagram:

1.   In the DEPARTMENT entity object, double-click the **PK attribute name** text box.
2.   Edit the text to read **DepartmentName**.
3.   Format the text as left aligned, normal, black text with defauklt fill color.
4.   The DEPARTMENT entity object now appears as shown in Figure G-13.
5.   Naming the other attributes is done the same way. And if we need more attributes (which we will for the *Phone* attribute), we just drag a new attribute object and attach it to the bottom of the entity object. The final DEPARTMENT entry is shown in Figure G-14.
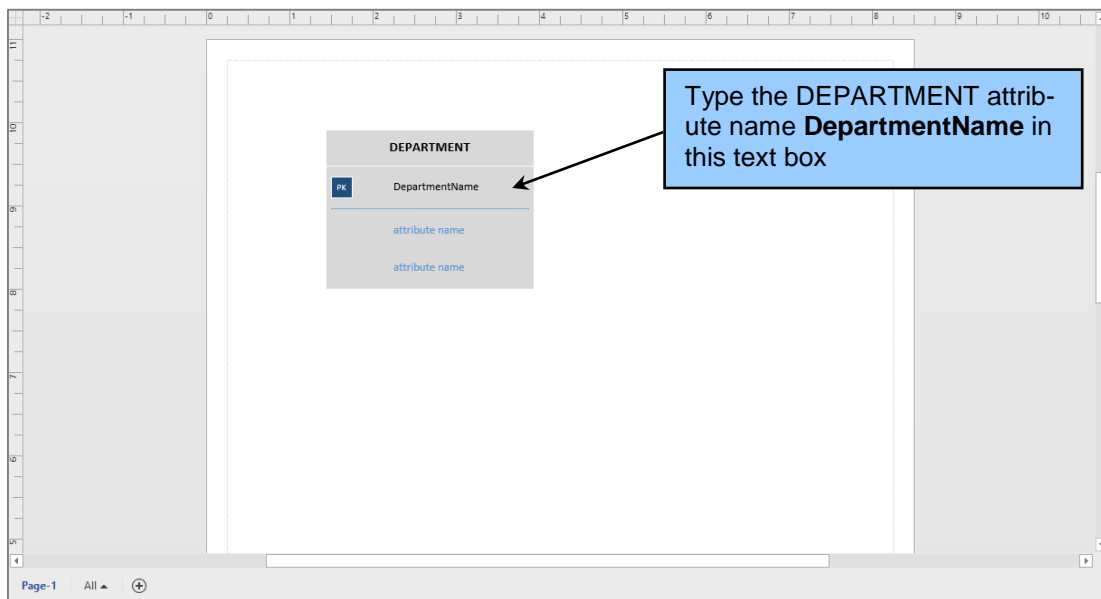
Figure G-13 — Naming the Primary Key Attribute
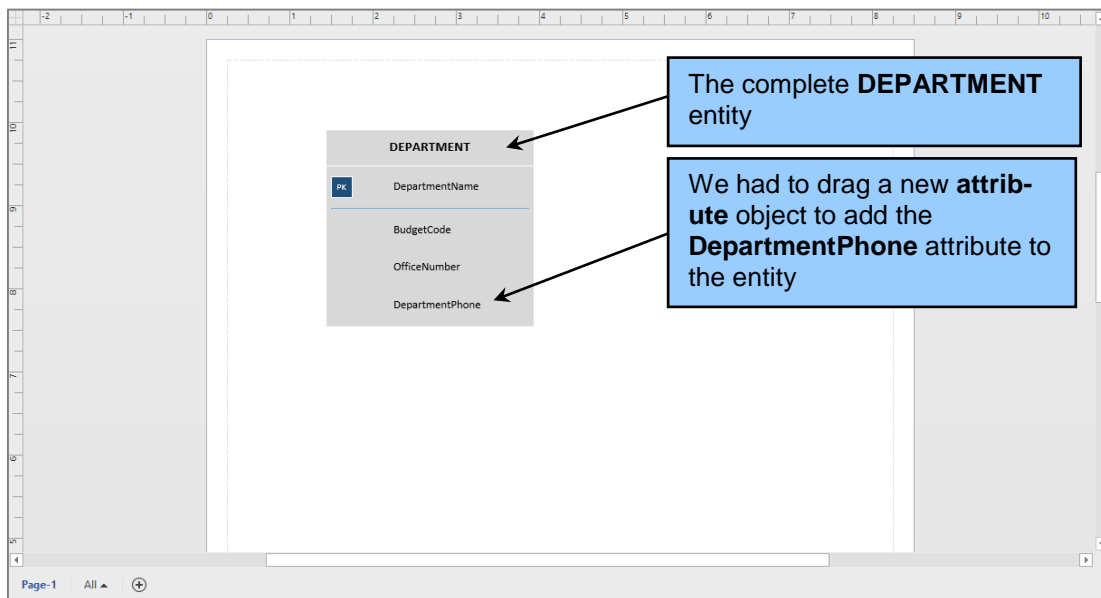
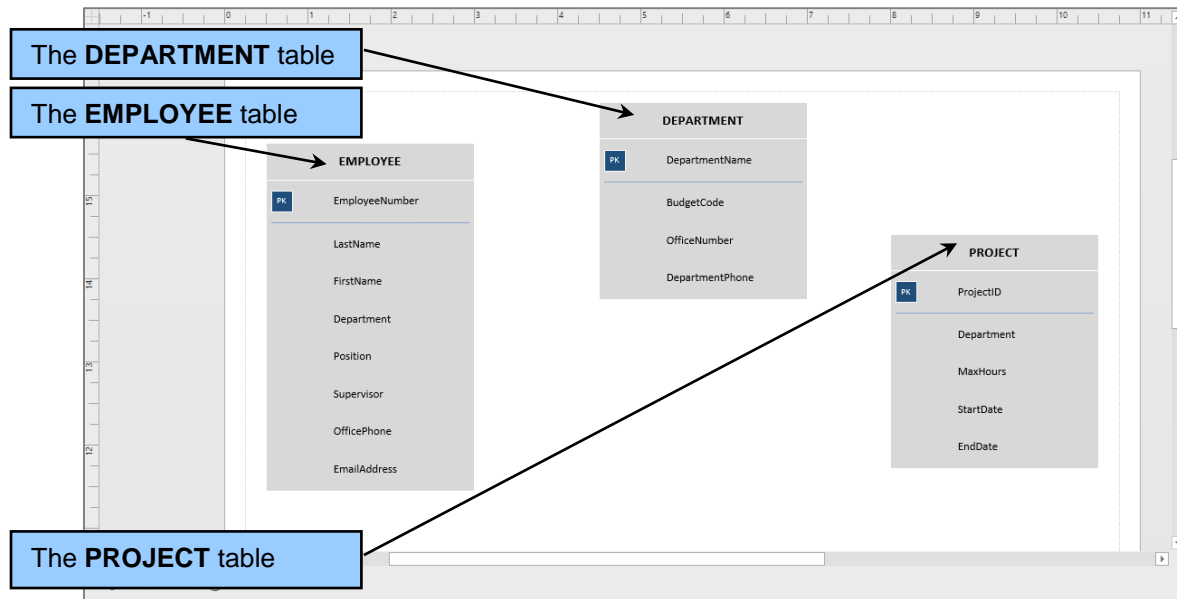**Figure G-14 — The Complete DEPARTMENT Entity**

Figure G-15 — The Completed DEPARTMENT, EMPLOYEE, and PROJECT Tables

Now we will build the EMPLOYEE and PROJECT tables, but we will wait to build the ASSIGNMENT table until we discuss how to create relationships. The process is similar to the process we used to build the DEPARTMENT table, and the results are shown in Figure G-15. Note that the table objects have been resized and rearranged, and the page itself is in landscape orientation instead of portrait orientation.

How Do I Create Relationships Between Entities in a Data Model Diagram in Microsoft Visio 2016?

Now that we have created the entities, we need to connect them with relationships. To do this we use the **Relationship** connector. This is really a renamed form of the standard Microsoft Visio 2016 **Dynamic connector**—used between two entities, this is just a line with formattable line endings.

The type of relationship displayed and other relationship parameters are controlled by the connector properties. That is how we know if we have, for example, a **1:1 non-identifying**, **1:N non-identifying**, or **1:N identifying** relationships.

> ### By The Way
>
> Microsoft Visio 2016 uses the term *non-identifying relationship*, whereas in DBC we use the term *nonidentifying relationship*. We have seen the term *non identifying relationship* used in other contexts. All three terms mean exactly the same thing, and which is used is a matter of style. Since Microsoft Visio 2016 uses *non-identifying*, we will also use that term in this appendix for consistency with the Microsoft Visio 2016 screen shots while remaining well aware that we have used *nonidentifying* in DBC itself.

It is also how we handle N:M relationships. In a data model, N:M relationships exist as N:M non-identifying relationships between two strong entities. In a database design, N:M relationships are

broken into two 1:N identifying relationships between three ID-dependent entities.

Now we will build a data model and a database design to consider exactly how Microsoft Visio 2016 handles these diagrams.

How Do I Create Data Models Using Relationships in Microsoft Visio 2016?

At this point, we need to create two 1:N non-identifying relationships, one between DEPARTMENT and EMPLOYEE and one between DEPARTMENT and PROJECT. We will start with the relationship between DEPARTMENT and EMPLOYEE

Creating a 1:N Nonidentifying Relationship Between Two Tables:

1.   Click-and-hold the **Relationship** object.
2.   Drag the object into the E-R diagram, and move it toward the center of the EMPLOYEE table. When the EMPLOYEE table is outlined in green, the connector is attached to the table object—release the mouse button. The E-R diagram now appears similar to Figure G-16.
3.   Locate the dynamic connector object in the E-R diagram, and drag the free end of it toward the center of the DEPARTMENT table. When the DEPARTMENT table is outlined in green, the connector is attached to the table object—release the mouse button. The E-R diagram now appears as shown in Figure G-17.
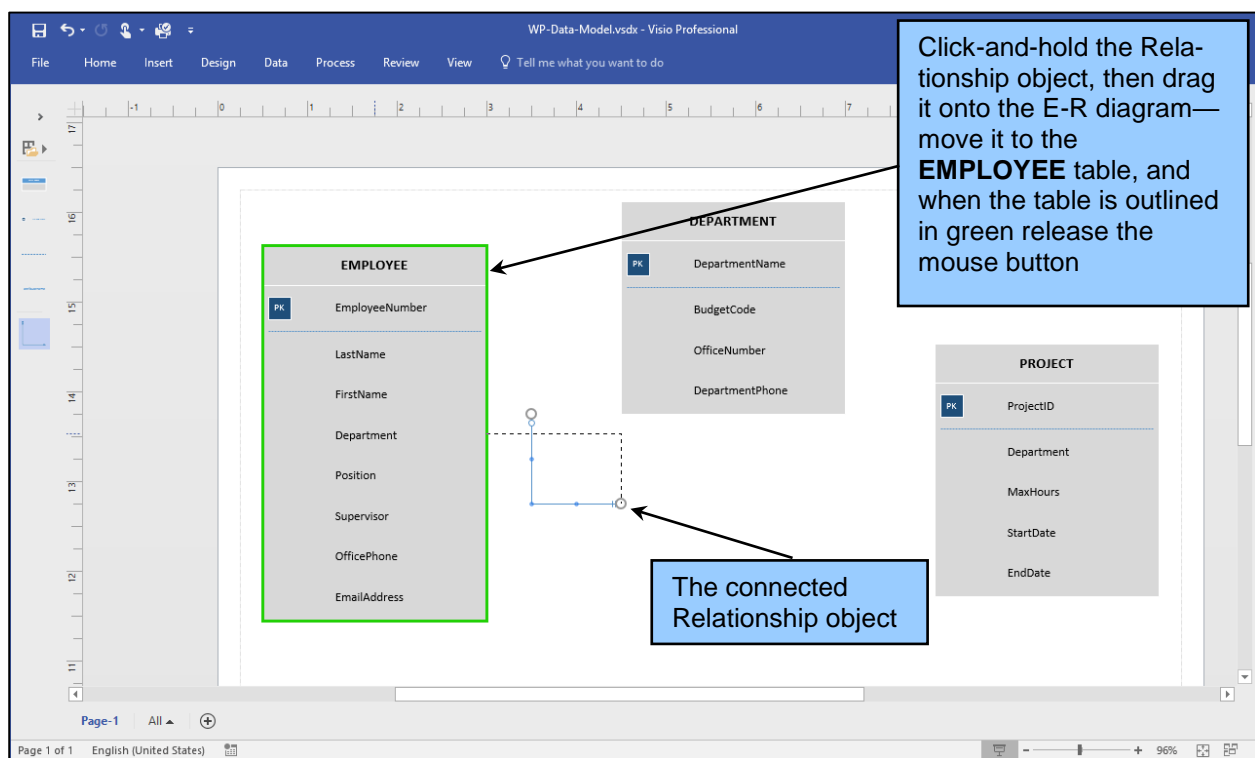

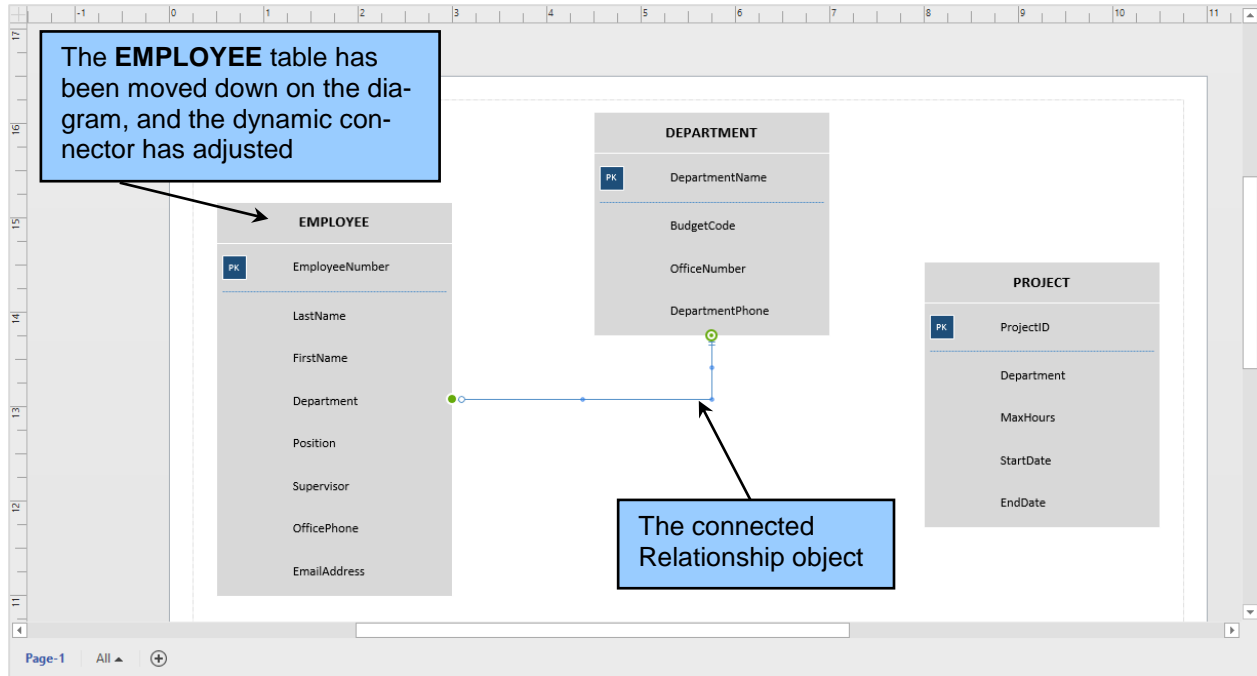**Figure G-16 — The Dynamic Connector Attached to the EMPLOYEE Table**

The **EMPLOYEE** table has been moved down on the diagram, and the dynamic connector has adjusted

The connected Relationship object

Figure G-17 — The Relationship Object Attached to Both the EMPLOYEE and DEPARTMENT Tables

The **DEPARTMENT** table has been moved to the left in the diagram, and the dynamic connector has adjusted

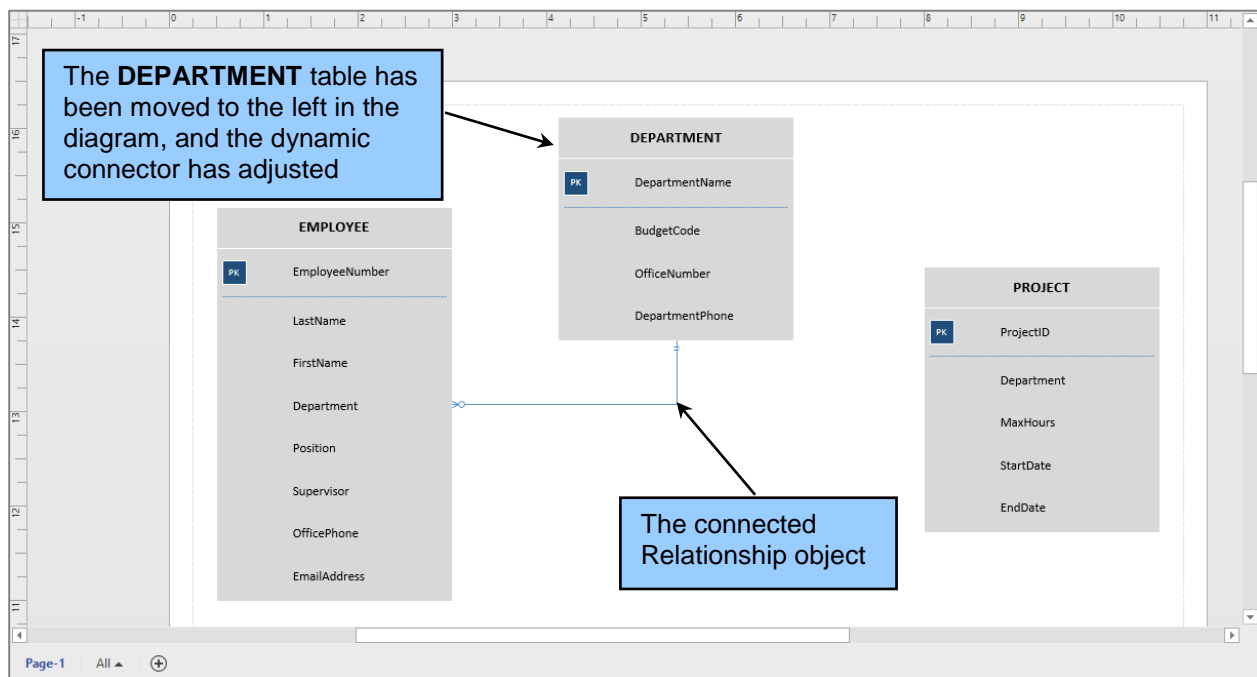The connected Relationship object

Figure G-18 — The Dynamic Connector Adjusts as DEPARTMENT Table is Moved

4.   The term *Dynamic Connector* means that if we move any of the objects to which the connector is attached, then the connector will automatically adjust its size and position to match. In Figure G-18, we have moved the DEPARTMENT table toward the center of the E-R diagram, and the

connector has adjusted itself as needed.

5.   We can format the line properties of the relationship. Click the relationship object to select it, and then right-click to display the shortcut menu as shown in Figure G-19.

6.   In the shortcut menu, click the **Set Begin Symbol** command to display the Set Begin Symbol menu. In the the Set Begin Symbol menu, note that Zero or more is set. To understand what Crow's Foot symbols this corresponds to, look at Figure G-20, which reproduces Figure 4-8. "Zero or more" corresponds to the optional-many Crow's Foot symbol.

7.   This is the correct setting for this line end, but note that we can easily adjust it to any of the four Crow's Foot symbols as needed.

8.   Since this is a non-identifying relationship, the line should be a dashed line, but Microsoft Visio 2016 does *not* allow us to format the line as a dashed line (the formatting options are available, but the selected formatting is *not* applied to the line!).

9.   The other end of the line is correct.

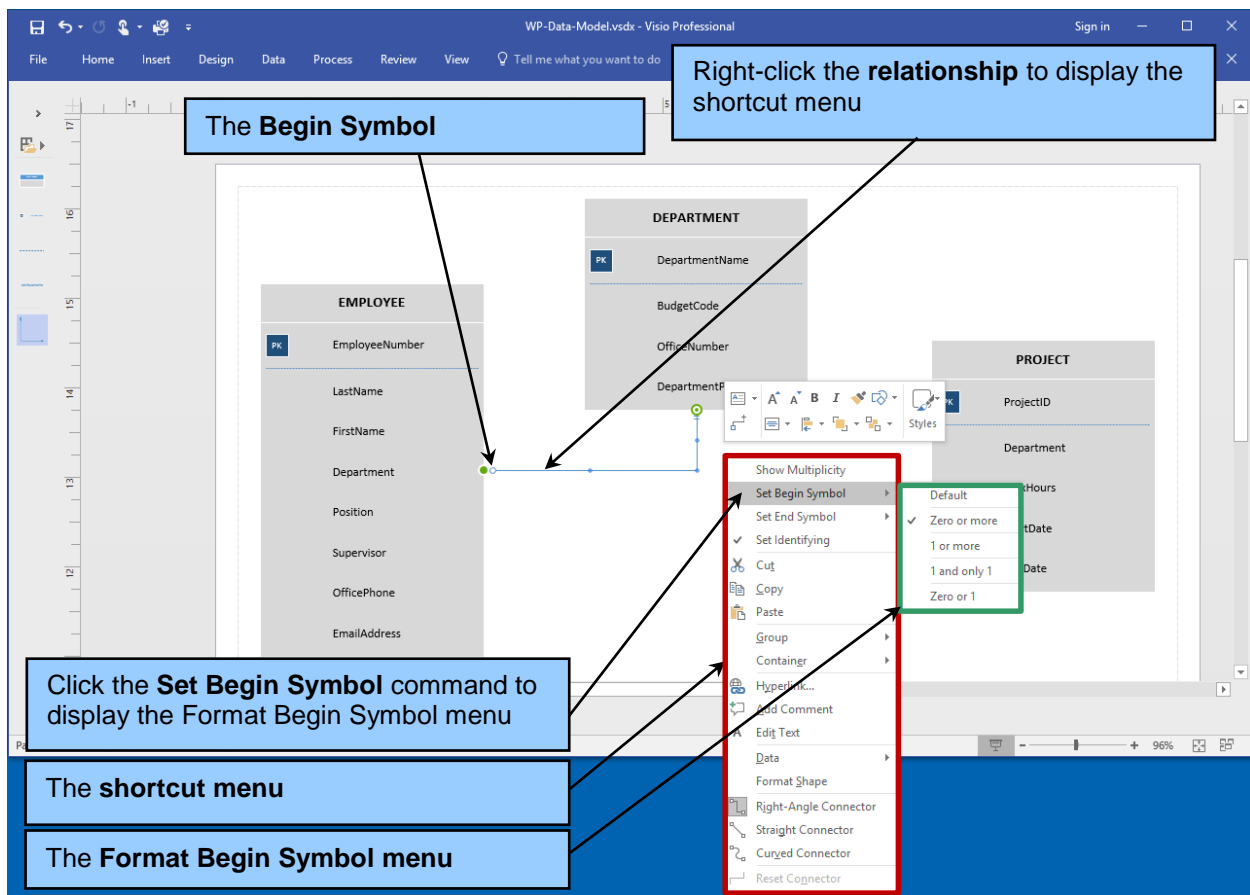10.   Click the **Save** button on the Quick Access Toolbar to save the work on the data model.

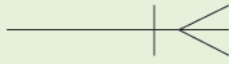

Figure G-19 — The Shortcut Menu
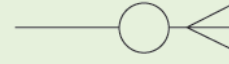
Symbol	Meaning	Numeric Meaning
	Mandatory—One	Exactly one
	Mandatory—Many	One or more
	Optional—One	Zero or one
	Optional—Many	Zero or more

Figure G-20 — Crow's Foot Symbols and Line Symbols

This allows us to format the relationship lines between the entities using the appropriate symbols for the style of E-R diagram we are creating. We can use these to create IE Crow's Foot data models. At this point, you need to simply experiment with how to format the connector lines in Microsoft Visio 2016. The relationship between DEPARTMENT and PROJECT is also a 1:N non-identifying relationship and can be created exactly the same way. The recursive 1:N non-identifying relationship within EMPLOYEE can be created in a similar manner. You should create those relationships now and save the data model work again. Note that creating the recursive relationship within EMPLOYEE may require some dexterity with the mouse!

Using Microsoft Visio 2016 relationships, we *can*, in fact, model N:M relationships. At this point, based on the WP database in Figure G-9, we still need to build the ASSIGNMENT table and its relationships with EMPLOYEE and PROJECT. However, for our WP data model, let's assume that we simply want an N:M relationship between EMPLOYEE and PROJECT. That is, employees will work on projects, and projects must have employees to work on them, and that we will not record hours worked. Figure G-21 shows the N:M relationship, using the same dynamic connector construction.

The important question for a *data model* design tool is whether or not we can model an N:M non-identifying relationship between two entities. As discussed in Chapters 4 and 5, an N:M relationship only exists in a data model (as a non-identifying relationship between two strong enties). In a database design, the N:M relationship becomes two 1:N ID-dependent identifying relationships linking the two original tables through a new, third table called an intersection table.
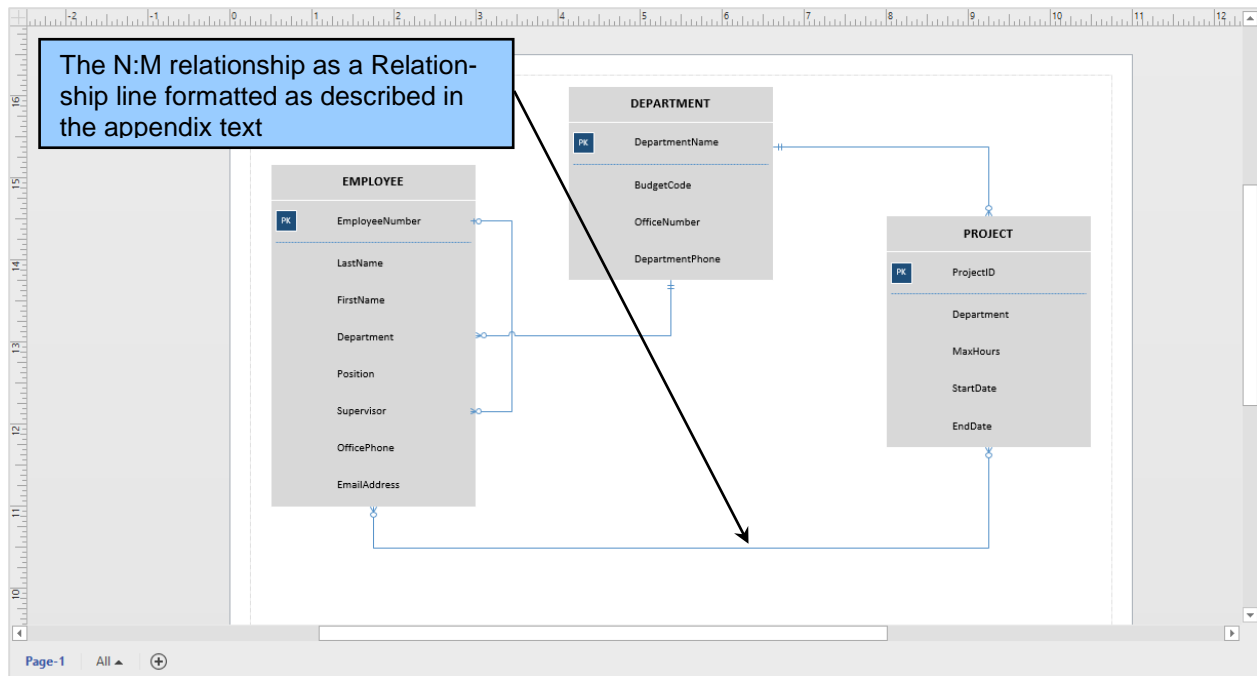
Figure G-21 — The N:M Relationship in the Data Model

At this point, you should create the N:M relationship and then save the WP-Data-Model.vsdx file. We will leave adding the ASSIGNMENT table to the data model for the Exercises at the end of this appendix.

In this model, the non-identifying relationships are correct (all three entities are strong entities), but what about the minimum cardinalities?

Does a DEPARTMENT have to have at least one employee? This is actually a business rule question, but we will assume that the answer for WP is yes, and that WP does not allow departments without employees to exist. This means we will need to change the EMPLOYEE end of the EMPLOYEE-to-DEPARTMENT relationship to "one or more."

Does an EMPLOYEE have to be assigned to a department? Again, this is a business rule question, but the fact that EMPLOYEE.Department is NOT NULL with a DEFAULT value of Human Resources is a good indication that the answer for WP is yes, and that WP does not allow employees unassigned to departments to exist, so the diagram is correct for that minimum cardinality.

We will also assume that every project has to have at least one employee assigned to it and that every employee has to work on at least one project. Therefore, the minimum cardinalities for the N:M relationship both need t be changed. Note that if optional minimum cardinalites are allowed, we just need to change which line end we use! The final WPdata model to this point, with the corrected line ends, is shown in Figure G-22. Save the WP-Data-Model.vsdx file a final time, and then click **File | Close** to close the drawing.

How Do I Create Database Designs Using Microsoft Visio 2016?

The unfortunate answer is you cannot do this well in Microsoft Visio 2016. **Microsoft Visio 2010** could do this and in our opinion was a much more flexible and versatile data modeling and database design tool than Microsoft Visio 2016. You can still open database designs created in Visio 2010 but without the previous functionality that they had in Visio 2010. Why did Microsoft remove so much capability from Visio 2010? We have no idea. But what a shame that it did!
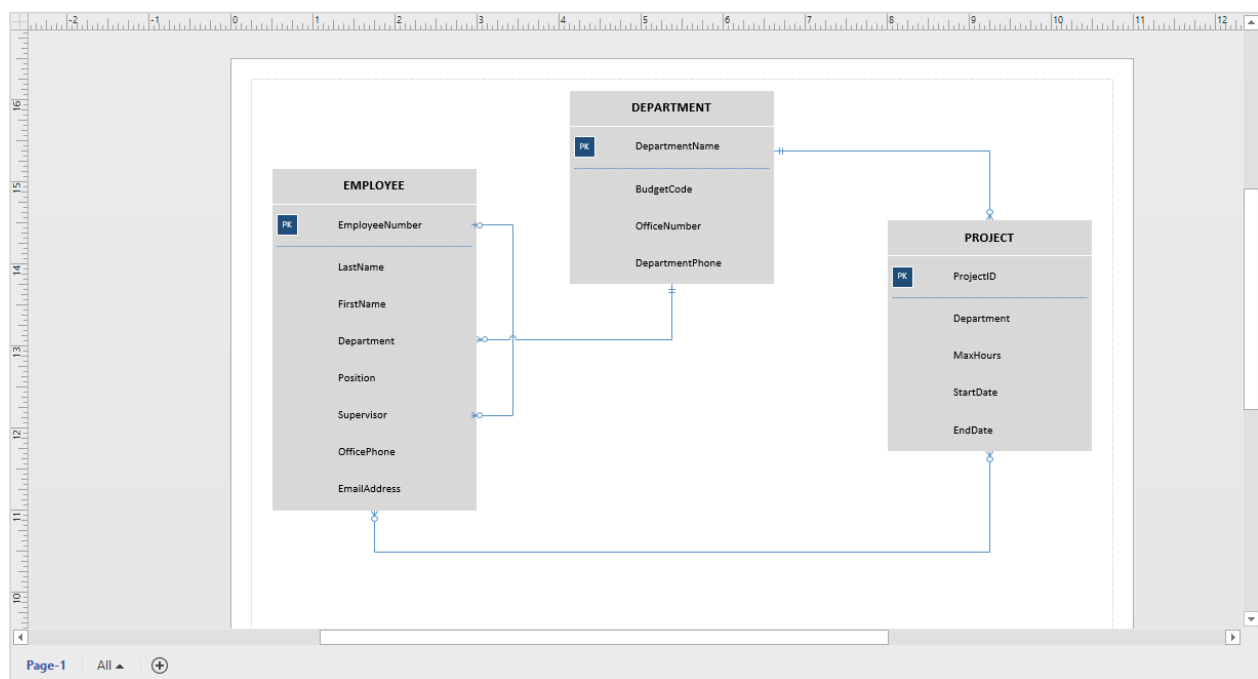

Figure G-23 — The Final WP Data Model

KEY TERMS

1:1 non-identifying relationship	1:N identifying relationship
1:N non-identifying relationship	Attribute object
Backstage view	Categories tab
Crow's Foot Database Notation button	Crow's Foot Database Notation stencil
Crow's Foot Database Notation template	dynamic connector
Entity object	File command tab
Microsoft Visio 2010	Microsoft Visio 2016
Minimize the Shapes window button	More Shapes button
More Shapes list	New tab
Primary Key Separator	Relationship connector
Relationship object	stencil
Software and Database template	

REVIEW QUESTIONS

G.1   What is Microsoft Visio 2016?

G.2   What is the Backstage view?

G.3   How do you create a new database model diagram drawing in Microsoft Visio 2016?

G.4   Describe the Shapes window and the objects in the Shapes window.

G.5   What shapes are included in the **Crow's Foot Database Notation** stencil, and what is the purpose of each shape?

G.6   How do you create entities in a data model diagram?

G.7   When should you use the Relationship connector object?

G.8   How do you format a Relationship object so that it displays IE Crow's Foot E-R notation?

G.9   How do you connect a Relationship object to two tables? What significance is there to which end of the Relationship is attached to which table?

G.10   How are Relationship connector cardinalities set? What is the correspondence between the cardinality terms used in the dynamic connector and the IE Crow's Foot E-R notation shown in Figure G-20?

EXERCISES

G.11   If you haven't already done so, work through the steps described in this appendix to create the data model and database design for the WP database.

G.12   Create a copy of the WP-Data-Model.vsdx file, and name it WP-Data-Model-with-ASSIGNMENT.vsdx. Modify the data model to include the ASSIGNMENT table as shown in the column characteristics in Figure G-9.

G.13   A data model for the Heather Sweeney Designs HSD database is shown in Figure 4-21[c]. In Microsoft Visio 2016, create a file named HSD-Data-Model.vsdx, and use it to recreate the data model shown in Figure 4-21[c].

G.14   The data model for the Wallingford Motors Customer Relationship WMCRM database is shown in Figure AW-4-1. In Microsoft Visio 2016, create a file named WMCRM-Data-Model.vsdx, and use it to recreate the data model shown in Figure AW-4-1.