Contents

Introduction

The purpose of this document is to introduce the @RISK Excel Developer Kit (XDK) and explain how you can use VBA to automate @RISK.[1] The term "automate" simply means that you write a program in VBA to make @RISK do what you normally do through the @RISK user interface. For example, suppose you often need to modify a financial planning simulation model. Each time you do this, you will change some inputs distributions or their parameters, run one or more simulations, request various reports, and create useful graphs. This requires a considerable number of steps—the same steps—each time you do it. Wouldn't it be nice to click a button and have all of these steps magically happen? This is exactly the type of thing you will learn how to do with the @RISK XDK. In fact, it is surprisingly easy.

A Primer on VBA[2]

As stated above, VBA is the programming language for Excel. It is also the programming language for other applications in Microsoft Office: Word, PowerPoint, and Outlook, for example. It is even the programming language for some non-Microsoft products. To understand how this works, it helps to separate the name VBA into two parts: "Visual Basic" and "for Applications." You can think of Visual Basic, or VB, as the "backbone" programming language. It contains programming elements that all programmers use, regardless of programming language or the type of development task. For example, it contains subroutines, variable types, logical constructs such as If-Then-Else, loops for repetitive tasks, arrays for storing lists, and much more. Actually, there are non-VBA versions of VB. For example, you might be familiar with VB.NET. All of these versions of VB, including VBA, are extremely popular because VB is fairly easy to learn and quite powerful. In any case, to learn VBA for Excel or @RISK, you must first learn the backbone VB language.

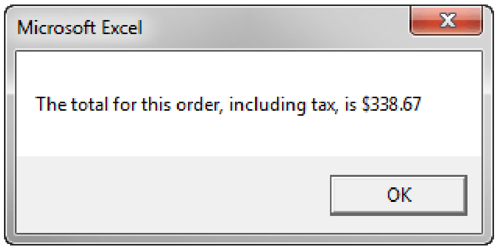
The following is a typical segment of VB code. Even if you know nothing about programming, you will probably have little trouble understanding what this code accomplishes. Again, this is the attraction of VB. It is relatively easy to learn and understand. Note the lines that begin with an apostrophe. These lines are **comments**. They are ignored by VBA when the program runs, but they are very useful for documentation.

[1] You must have the Professional or Industrial Edition of @RISK to run any automation code. The Standard Edition of @RISK does not support automation.
[2] If you are already familiar with VBA for Excel, you can skip to the section "Introduction to the @RISK XDK" on page 5.

```
Sub Invoice()
    ' Declare variables.
    Dim nProducts As Integer, i As Integer
    Dim total As Currency, subTotal As Currency
    Dim nPurchased As Variant, unitPrice As Variant

    ' Define constants for this business.
    Const taxRate = 0.06
    Const cutoff1 = 50, cutoff2 = 100
    Const discount1 = 0.05, discount2 = 0.1

    ' Enter information about this order
    nProducts = 4
    nPurchased = Array(5, 2, 1, 6)
    unitPrice = Array(20, 10, 50, 30)

    total = 0
    ' Loop over all products purchased.
    For i = 1 To nProducts
        ' Calculate revenue, including possible discount, for this product.
        subTotal = nPurchased(i) * unitPrice(i)
        If subTotal >= cutoff2 Then
            subTotal = (1 - discount2) * subTotal
        ElseIf subTotal >= cutoff1 Then
            subTotal = (1 - discount1) * subTotal
        End If
        ' Add to total for this order.
        total = total + subTotal
    Next
    ' Add tax.
    total = (1 + taxRate) * total
    ' Display result.
    MsgBox "The total for this order, including tax, is " & Format(total, "$#,#00.00")
End Sub
```

If you run this code in Excel, you will see the display (a message box) in Figure 1.

Figure 1 Result of VBA Program



The total for this order, including tax, is $338.67

Subroutines, Programs, and Macros

Before proceeding, it is useful to discuss three terms you often hear: subroutine, program, and macro. A **subroutine** is any section of code that begins with the keyword Sub and ends with the keyword End Sub. Its purpose is typically to perform one specific task. A **program** is a collection of one or more related subroutines that achieves an overall goal. In practice, long programs are often broken up into smaller subroutines for enhanced readability and easier debugging. A **macro** is essentially the same as a program, and it is the term favored by many Excel programmers. However, if your programs are relatively short, consisting of a single subroutine, the terms subroutine, program, and macro are practically synonymous and are often used interchangeably.

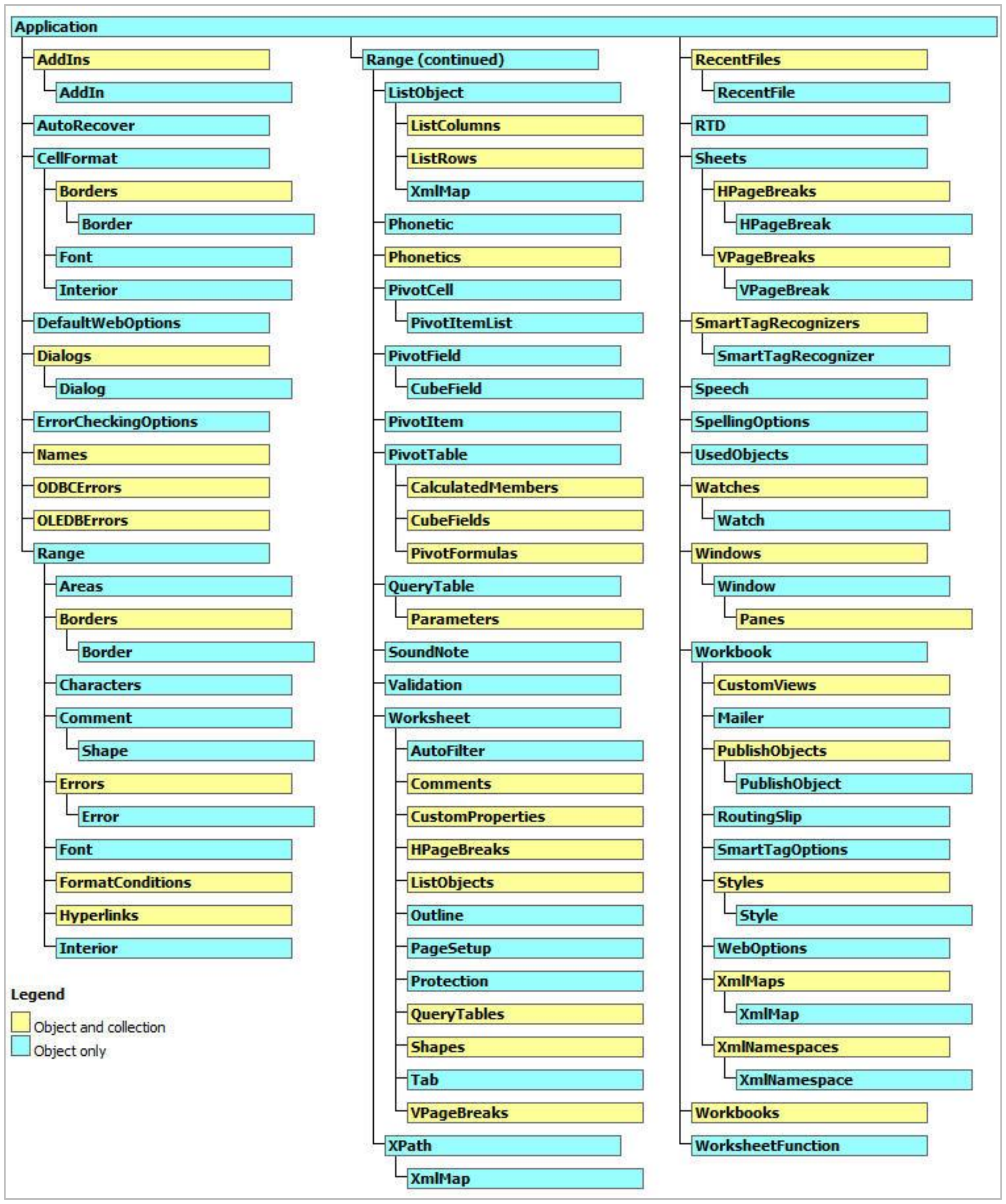
Object Models

The above Invoice subroutine can be run in Excel, but it really has nothing to do with Excel. There are no references to ranges, formulas, worksheets, charts, or other items you use in Excel. The code is pure VB. But now we come to the "for Applications" part of VBA. All of the familiar items in Excel, which will now be called **objects**, are part of an **object model** that Excel provides to programmers through VBA. This means that you as a programmer can reference these objects in your VBA code. In short, this object model allows you to "make things happen" through VBA code, rather than through the usual Excel user interface. In this way, you can automate Excel with VBA.

So what does an object model, or Excel's object model in particular, look like? At the top level, it is simply a list of things—objects—that the software contains. Excel's object model is quite large because everything you see in Excel is an object. One of the most common objects is the Range object: any range of cells (including a single cell). But there are over a hundred more objects, including the Worksheet object, the Chart object, the PivotTable object, and so on. There are also singular and plural objects. For example, there is the plural Worksheets object, the collection of all worksheets in an Excel workbook, and there is the singular Worksheet object, a particular worksheet in the workbook.

Figure 2 displays a partial list of the objects in Excel, plural (yellow) and singular (blue).

Figure 2 Excel Object Model



However, there is much more to an object model than the list of its objects. First, there is a **hierarchy** among many objects. Basically, this means that you often need to "drill down" to get to the object you want. A good example is a Range object, such as cell B3. The idea is that a range is contained in a worksheet, which is contained in a workbook. So the hierarchy is Workbook→Worksheet→Range, and the following line of code is typical:

```
ActiveWorkbook.Worksheets("Costs").Range("B3").Value = 10
```

You read this as: Starting in the active workbook, go to cell B3 of the worksheet named Costs, and enter the value 10. This concept of hierarchy is crucial to learning VBA for Excel or @RISK.

Second, most objects have **properties** and **methods**. (Methods are also called **functions**.) If you think of objects as "nouns," then you can think of properties as "adjectives" and methods as "verbs." Properties describe an object, and methods indicate what you can do to, or with, an object. For example, a Range object has a Value property, which was used in the above line of code. Similarly, a Font object has a Color property, a Size property, and many others. A typical object with methods is the Worksheet object. It has a Delete method, a Move method, and a few others.

Although less common, many objects also have **events** that they respond to. A good example is the Open event of a Workbook object. This event occurs—it "fires"—when you open the workbook. VBA allows you to write **event handlers** for the event. This is code that is executed when the event fires.

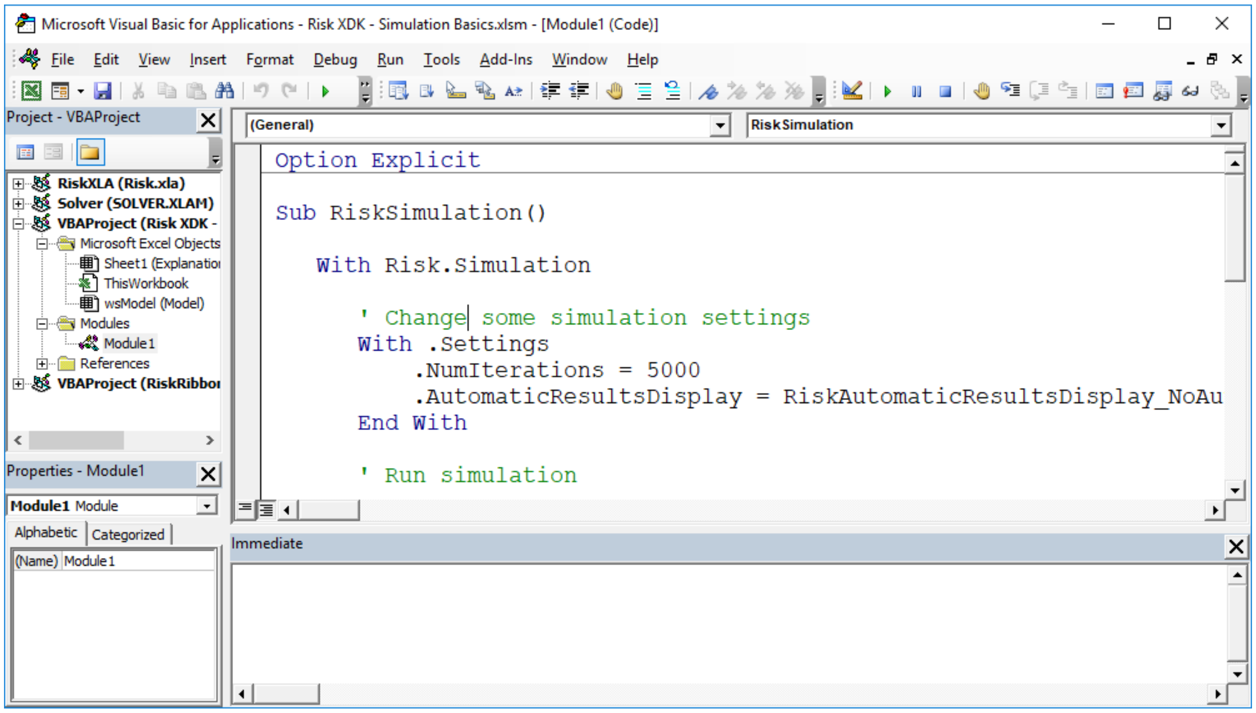
As you begin VBA programming for Excel, you gradually learn the most common objects, the hierarchies between them, their most common properties, methods, and events, and the syntax for using these in VBA code. It takes practice and perseverance, but if you want to make Excel "sing and dance" with the click of a button, this is time well spent.

By now, you should be starting to see the big VBA picture. Just as the Excel application can be automated through its object model, other applications can be automated through *their* object models. Microsoft Word is a typical example. Its objects are not the same as Excel's. Instead of Worksheet, Range, and other typical Excel objects, Word has Sentence, Paragraph, and other objects that are useful in word processing, and these objects have their own hierarchies, properties, methods, and events. Fortunately, if you already know VBA for Excel and you want to learn VBA for Word, all you need to learn is the object model for Word. The backbone VB language is exactly the same in both applications. Admittedly, it is not a trivial task to learn a new application's object model, but knowing VB for one application, like Excel, provides a big head start for learning VB for another application, like Word.

Using the Visual Basic Editor (VBE)

You will be doing all of your programming in the Visual Basic Editor (VBE). The easiest way is to open VBE from Excel is to press **Alt+F11**. Alternatively, if the Excel Developer tab is visible, you can click the **Visual Basic** button on its ribbon. The VBE window appears in Figure 3. In particular, the Project pane on the left shows a list of all open workbooks. (To get back to the Excel window, you can click the Excel icon on the toolbar below the menu bar.)

Figure 3 Visual Basic Editor



```
Option Explicit

Sub RiskSimulation()

   With Risk.Simulation

      ' Change some simulation settings
      With .Settings
          .NumIterations = 5000
          .AutomaticResultsDisplay = RiskAutomaticResultsDisplay_NoAu
      End With

      ' Run simulation
```

As you can see in the figure, the selected file contains a module. You will write all of your code in modules. (Actually, there are exceptions to this, but they aren't discussed here.) By default, a file doesn't contain a module, but you can insert one through the Insert menu. Then you will see a big white space on the right where you can start typing your code. Some of the code for this particular module appears in the figure.

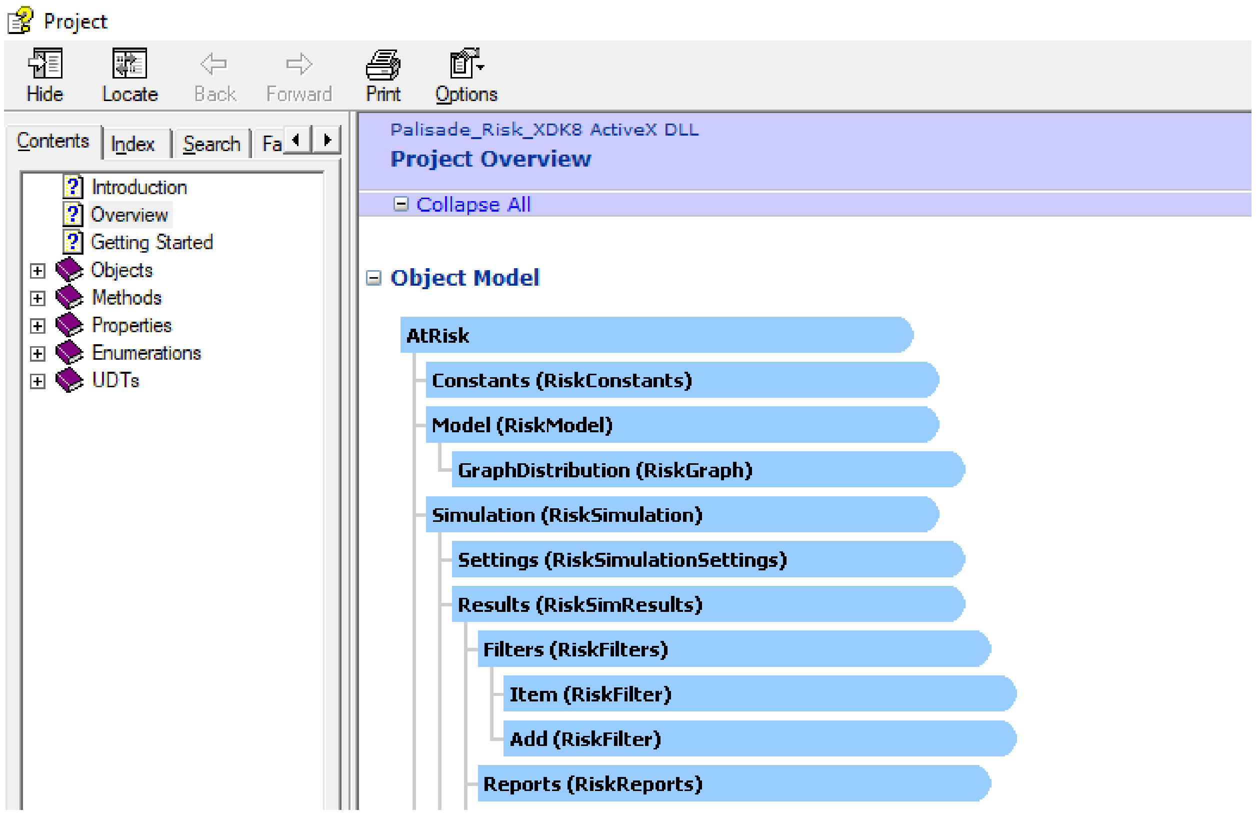
Introduction to the @RISK XDK

Like Excel and Word, @RISK has its own object model, part of which is shown in Figure 4. It can be used to change application or simulation settings, run simulations, generate summary statistics or graph of inputs or outputs, create reports, and more. The details of these possibilities are discussed in some detail later in this document and in the accompanying @RISK XDK example files.

Two questions probably come to mind. Do you really need to learn how to automate @RISK with VBA, and, if you do, how do you learn the language?

There are at least two reasons why you might want to automate @RISK with VBA. First, it lets you automate tasks that you perform repeatedly. For example, suppose you need to download the most current data from a website, use @RISK to fit a distribution to the data, run an @RISK simulation, and finally create some standard @RISK reports. If you do this once or twice, it is probably not worth the effort to write a VBA program to automate the process. However, if you do this repeatedly, a VBA program can replace *many* mouse clicks with a *single* click. Indeed, this is why VBA for Excel is so popular among users—it lets them automate repetitive tasks with the click of a button. The same motivation certainly applies to repetitive tasks in @RISK.

Figure 4 @RISK Object Model



AtRisk
- Constants (RiskConstants)
- Model (RiskModel)
  - GraphDistribution (RiskGraph)
- Simulation (RiskSimulation)
  - Settings (RiskSimulationSettings)
  - Results (RiskSimResults)
    - Filters (RiskFilters)
      - Item (RiskFilter)
      - Add (RiskFilter)
    - Reports (RiskReports)

Second, suppose you are developing models for colleagues or clients who have little experience with @RISK. Instead of teaching them how the @RISK user interface works, it might be easier to develop a VBA application that allows them to simply click a button, or possibly click a menu item from your own customized menu, to make things happen. These "things" could include (1) entering @RISK distributions into particular cells, (2) designating @RISK outputs, (3) changing @RISK settings, (4) running the simulation, (5) displaying selected graphs and/or summary statistics, and other @RISK tasks.

Assuming you think VBA for @RISK is for you, how do you learn the language? First, you need some facility in VBA for Excel. As discussed earlier, this requires you to learn the fundamentals of the VB "backbone" language and the basics of the Excel object model. There are a number of reference books on VBA for Excel, as well as Excel's own online help. One recommendation is the first 11 chapters of *VBA for Modelers* by Albright. This book provides concise explanations and plenty of example code to get you up to speed in both the VB language and the Excel object model.

Once you are familiar with VBA for Excel, you have at least four options—which are not mutually exclusive—for extending your knowledge to VBA for @RISK.

1. You can continue reading this document. It provides an overview of what can be done, and it provides sample code for how to do it. Alternatively, you can watch the first two introductory videos

that cover much of the same material. They are available from the Developer Kit (XDK) item under @RISK Help.

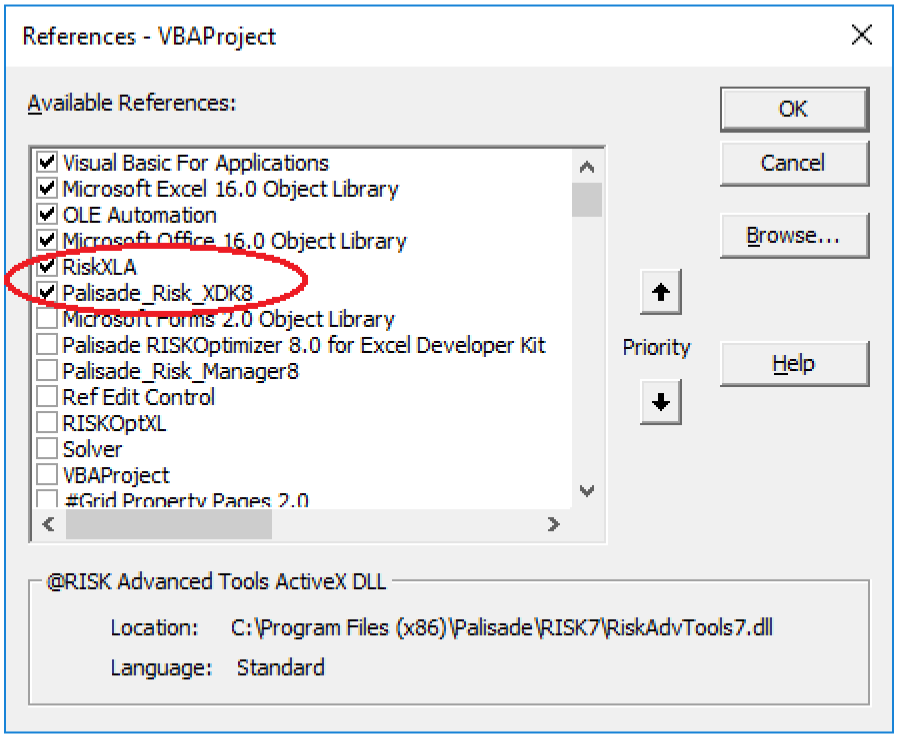
2. You can do what all good programmers do—mimic code written by others. Examples of programs written for @RISK are provided in a number of @RISK XDK example files. (They can be found from Developer Kit (XDK) item under @RISK Help.) Once you see how something is done, such as changing an @RISK setting or creating an @RISK graph, you will probably have little difficulty adapting the code for your own use.
3. You can open one of the Reference documents from the Developer Kit (XDK) item under @RISK Help and start browsing. These documents are quite long, and no sane person would ever read them from beginning to end, but they give you a quick sense of the @RISK object model (or the RISKOptimizer object model), and they often enable you to find the specific details you need for your program.
4. You can open the Object Browser that is part of the Visual Basic Editor. This is particularly useful if you are in the midst of writing a program and need information on one specific detail. The Object Browser is discussed later in this document.

By the way, if you are familiar with VBA for Excel, you might want to start by *recording* macros for @RISK, just as you can do for Excel. Unfortunately, this doesn't work. If you turn on the recorder and start clicking @RISK buttons, you will get *some* recorded code, but it will be entirely irrelevant. To automate @RISK, *you* have to write the code.

Setting Library References

Before you can access the @RISK XDK with VBA code, you must first set references to two @RISK libraries (from References in the Tools menu of the Visual Basic Editor). These are the **RiskXLA** and **Palisade_Risk_XDK8** references, illustrated in Figure 5. (The former references the Risk.xla add-in file. The latter contains the @RISK Object Model.) This should be the first step before writing any VBA macros to automate @RISK. If you plan to automate RISKOptimizer, you will need to check **Palisade RISKOptimizer 8.x for Excel Developer Kit** reference too; that reference is also listed in the screen shot.

Figure 5 @RISK References


References - VBAProject

Available References:

- [✓] Visual Basic For Applications
- [✓] Microsoft Excel 16.0 Object Library
- [✓] OLE Automation
- [✓] Microsoft Office 16.0 Object Library
- [✓] RiskXLA
- [✓] Palisade_Risk_XDK8
- [ ] Microsoft Forms 2.0 Object Library
- [ ] Palisade RISKOptimizer 8.0 for Excel Developer Kit
- [ ] Palisade_Risk_Manager8
- [ ] Ref Edit Control
- [ ] RISKOptXL
- [ ] Solver
- [ ] VBAProject
- [ ] #Grid Property Pages 2.0

@RISK Advanced Tools ActiveX DLL

Location: C:\Program Files (x86)\Palisade\RISK7\RiskAdvTools7.dll

Language: Standard

Writing Your First @RISK Program

This section won't teach you a lot about VBA for @RISK, but it will give you the thrill of developing a simple @RISK application with VBA—and getting it to work! Here are the steps:

1. Launch @RISK. (This document assumes you are using version 8.x.)
2. Select the **Tutorial (before Code Added)** item from the Automating @RISK (XDK) menu under the Resources ribbon item and save it to a folder on your hard drive. This file contains a simple @RISK model with several revenue and cost inputs and a single NPV output.
3. Open the Visual Basic Editor (VBE) with **left Alt+F11**.
4. Make sure the correct item is selected in the Project pane. Then from the VBE's Insert menu, select **Module**.
5. From the VBE's Tools menu, select **References**, check the two @RISK items shown in Figure 5, **RiskXLA** and **Palisade_Risk_XDK8**, and click OK.
6. Copy the following code and paste it into the Module window.[3]

```
Option Explicit

Sub FirstProgram()

   ' Obtain object representing the worksheet where we'll place the results.
   Dim modelWorksheet As Worksheet
   Set modelWorksheet = Worksheets("Model")
```

[3] The top line, Option Explicit, forces you to declare all variables you use in your program, a highly recommended programming practice. To make this line appear automatically at the top of all your modules, select Options from the Tools menu in the Visual Basic Editor and check Require Variable Declaration in the Editor tab.

```
    ' Change some simulation settings
    With Risk.Simulation.Settings
        .NumSimulations = 1
        .NumIterations = 5000
        .AutomaticResultsDisplay = RiskAutomaticResultsDisplay_NoAutomaticResults
    End With

    ' Run simulation
    Risk.Simulation.Start

    ' Display results
    With Risk.Simulation.Results
        ' Summary statistics of output
        With .GetSimulatedOutput("NPV")
            modelWorksheet.Range("C19").Value = .Mean
            modelWorksheet.Range("C20").Value = .StdDeviation
            modelWorksheet.Range("C21").Value = .PToX(0.05)
            modelWorksheet.Range("C22").Value = .PToX(0.95)
        End With

        ' Use cell E19 to define the location of the graph.
        Dim left As Long
        Dim top As Long
        left = modelWorksheet.Range("E19").left
        top = modelWorksheet.Range("E19").top

        ' Graph of output distribution
        With .GraphDistribution("NPV")
            .ImageToWorksheet modelWorksheet, RiskImageFormat_BMP, left, top, 300, 250
        End With
    End With
End Sub
```

7. From the VBE's Run menu, select **Run Sub/Userform** (or press the F5 key). In seconds, your active Model worksheet should fill up: the @RISK simulation will run and selected numerical and graphical results will appear. Now you see what automation is all about!

This program should be fairly simple to read, even if you know very little about VBA. The results of this exercise should be just like in the workbook that can be opened using the **Tutorial (after Code Added)** menu item. The next "Guidelines" section explains many of the details, and the following "VBA Tips" section provides some general tips on using VBA effectively.

@RISK Automation Guidelines

This section provides some guidelines for automating @RISK with VBA code. The guidelines in this section are purposely kept brief and are intended only to get you started and alert you to a few technical issues. To see complete applications of @RISK automation, you should look at the examples, available in the Automating @RISK XDK menu under the Resources ribbon item. Also, you can always visit the @RISK XDK Reference documents or the Object Browser in the Visual Basic Editor.

Getting Started: the "Root" Object

The "root" object that everything starts from is the **Risk** object, a reference to @RISK. All other @RISK objects are down the hierarchy from it. For example, you will see Risk.Model, Risk.Simulation, and others. Many of these will be discussed shortly.

Technical Note: Risk Function versus AtRisk Object

There is a subtle issue here you should be aware of. As it is used here, **Risk** is a *function* in the RiskXLA library that returns an **AtRisk** *object* from the object library. To put it another way, if you did *not* reference the RiskXLA library and wrote a typical line such as the following, Risk wouldn't be recognized.

```
Risk.Simulation.Settings.NumIterations = 1000
```

However, if you *do* reference RiskXLA, as you should, you can simply write Risk, followed by any of its properties or methods, and it will work fine. (In particular, you do *not* need to declare Risk as an object variable.)

Running a Simulation

Risk.Simulation refers to the simulation model currently open. You can use it to run a simulation with a single line of code:

```
Risk.Simulation.Start
```

Technical Note: What Is a Simulation?

It is important to realize what a "simulation" refers to, either in VBA or in the @RISK user interface itself. It refers to everything that is currently open. For example, if you have logically distinct simulations in multiple worksheets of a workbook, Risk.Simulation refers to *all* of them. Or if you have multiple workbooks open, each with its own logically distinct simulation, Risk.Simulation again refers to *all* of them. There is no way to refer to one specific simulation among many, so be careful!

Changing Simulation Settings

You get to the simulation settings with **Risk.Simulation.Settings**. Then you can have code such as the following that changes a few settings. Of course, this code should come *before* the line that runs the simulation.

```
With Risk.Simulation.Settings
    .NumSimulations = 5
    .NumIterations = 5000
    .AutomaticResultsDisplay = RiskAutomaticResultsDisplay_NoAutomaticResults
End With
Risk.RefreshUI ‘ this line ensures that the Excel ribbon will update to show the changes
```

Displaying Numeric Results of a Simulation

Once you run a simulation, you can get to the results with **Risk.Simulation.Results**. This can be followed by two functions, **GetSimulatedInput** and **GetSimulatedOutput**, which enable you to get summary statistics such as the mean, the standard deviation, and percentiles of an input or output. For example, the following line enters the mean of the Profit output in cell B20.

```
Range(“B20”).Value = Risk.Simulation.Results.GetSimulatedOutput(“Profit”).Mean
```

Alternatively, assuming multiple simulations are run, the following line enters the 5th percentile of the Q1_Cost input for simulation #3 in cell B15.

```
Range(“B15”).Value = Risk.Simulation.Results.GetSimulatedInput(“Q1_Cost”,3).PToX(0.05)
```

The arguments of GetSimulatedOutput specify the output you want. The first argument is either the name of the output, implicitly or explicitly defined in the RiskOutput function, or a cell reference. (It can also be an integer, such as 3, meaning the third output, but this isn't usually a good practice unless you are sure of the ordering of the outputs.) An optional second argument when there are multiple simulations is the index of the simulation. The arguments of GetSimulatedInput are similar, except that if a name is used for the first argument, it must be the name specified in the RiskName property function. For example, if the formula in an input cell is **=RiskNormal(1000,100,RiskName("Q1_Cost"))**, then the name "Q1_Cost" can be referenced.

Note that if you ask for the results of a simulation that has not yet been run, you will get an error. You can check for this with the following line:

```
If Not Risk.Simulation.Results.Exist Then Risk.Simulation.Start
```

Alternatively, if this condition is true (no simulation results exist), you could display an error message, informing the user that a simulation needs to be run, and then quit prematurely. The following code illustrates what this might look like.

```
Sub RunWithErrorCheck()
    If Not Risk.Simulation.Results.Exist Then
        MsgBox "You need to run a simulation first.", vbInformation
        Exit Sub
    Else
        Range("B20").Value = Risk.Simulation.Results.GetSimulatedOutput("Profit").Mean
    End If
End Sub
```

Displaying Graphical Results of a Simulation

You can use the **RiskGraph** object to create a variety of graphs. Starting with **Risk.Simulation.Results**, you can use a number of functions that return a RiskGraph object: GraphDistribution, GraphScatter, GraphSensitivityTornado, etc. Because these functions return different types of graphs, their arguments vary slightly, as will be explained shortly. However, you typically use the following three steps with all of them.

1. Set a reference to a graph.

```
Dim rGraph As RiskGraph
Set rGraph = Risk.Simulation.Results.GraphDistribution("Profit")
```

2. Change one or more properties of the graph.

```
rGraph.TitleMainText = "Distribution of Profit"
```

3. Send the image of the graph to a worksheet, where the last four arguments determine the size and position of the graph. (You can also send the image to the clipboard or to a file with the ImageToClipboard or ImageToFile functions.)

```
rGraph.ImageToWorksheet ActiveSheet, RiskImageFormat_BMP, 100, 100, 300, 250
```

Equivalently, you can do all of these steps with the following With block, without requiring the rGraph variable. Note that the first line creates an implicit RiskGraph object, so that you can refer to its TitleMainText property and its ImageToWorksheet method in the next two lines.

```
With Risk.Simulation.Results.GraphDistribution("Profit")
     .TitleMainText = "Distribution of Profit"
     .ImageToWorksheet ActiveSheet, RiskImageFormat_BMP, 100, 100, 300, 250
End With
```

Should you use explicit object variables such as rGraph? This is a matter of personal preference, and it sometimes depends on the situation. However, once you get used to programming with object models, you will probably prefer to omit such variables whenever possible.

The following sections provide more information about the graph types. Of course, you can find detailed information in online help or the Object Browser. Keep in mind that the graphs shown in the figures are "plain vanilla" versions, which often suffice. However, you can change the many properties of a RiskGraph object to fine-tune the graph as you like: the titles, the axes, the plot area color, and so on.

GraphDistribution Function

The GraphDistribution function is usually used to graph the distribution of an output, although it can also be used to graph the distribution of an input. This function takes an output, an input, or an array of inputs and/or outputs as its first argument and an optional second argument that can be a simulation index or an array of simulation indexes.[4] Here is a simple example. The result appears in Figure 6.

```
Sub GraphDistribution_Histogram()
    Risk.Simulation.Start
    With Risk.Simulation.Results.GraphDistribution("Profit")
        .ImageToWorksheet ActiveSheet, RiskImageFormat_BMP, 10, 300, 300, 250
    End With
End Sub
```

By default, this code provides a histogram, but you can use the DistributionDisplayFormat property to change the display type. For example, the following code changes the display type to a cumulative ascending graph, as shown in Figure 7.

```
Sub GraphDistribution_CumulativeAscending()
    Risk.Simulation.Start
    With Risk.Simulation.Results.GraphDistribution("Profit")
        .DistributionDisplayFormat = RiskDistributionDisplayFormat_CumulativeAscending
        .ImageToWorksheet ActiveSheet, RiskImageFormat_BMP, 10, 300, 300, 250
    End With
End Sub
```

[4] Actually, if you are graphing an input, there is an optional third Boolean argument, indicating whether you want to suppress an overlay of the theoretical distribution on the graph. It is False by default.

Figure 6 Graph of Profit Distribution

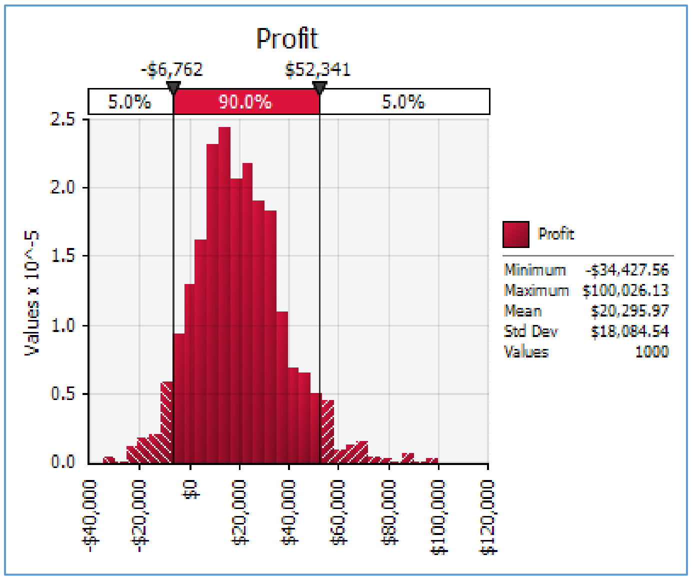
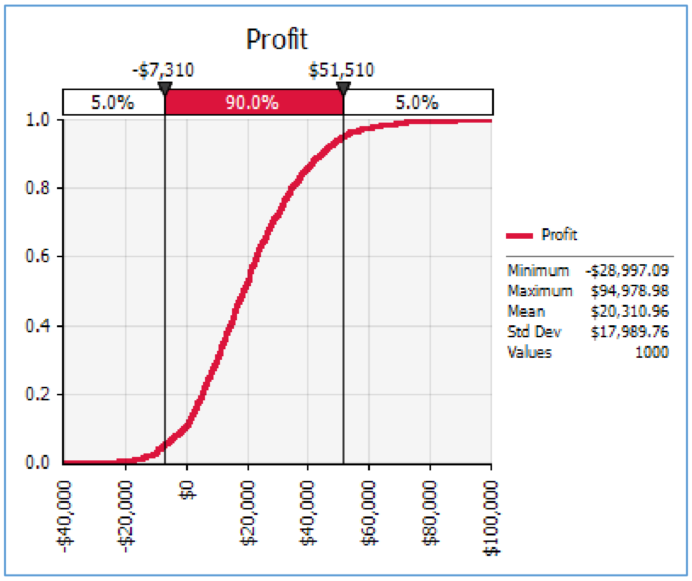


Figure 7 Cumulative Ascending Graph of Profit Distribution



The following code requests a graph of a Profit output, overlaid with a Q1_Cost input, for simulation #2. The last argument, True, indicates that the theoretical distribution of the input *should* be suppressed. The result is shown in Figure 8.

```
Sub GraphDistribution_HistogramOverlay1()
    Risk.Simulation.Start
    With Risk.Simulation.Results.GraphDistribution(Array("Profit", "Q1_Cost"), 2, True)
        .ImageToWorksheet ActiveSheet, RiskImageFormat_BMP, 10, 300, 300, 250
    End With
End Sub
```

As another example, the following code requests a graph of Profit for simulation #1, overlaid with a similar graph for simulation #3, as shown in Figure 9.

```
Sub GraphDistribution_HistogramOverlay2()
    Risk.Simulation.Start
    With Risk.Simulation.Results.GraphDistribution("Profit", Array(1, 3))
        .ImageToWorksheet ActiveSheet, RiskImageFormat_BMP, 10, 300, 300, 250
    End With
End Sub
```

Figure 8 Graph of Profit Distribution with Q1_Cost Overlay for Simulation #2

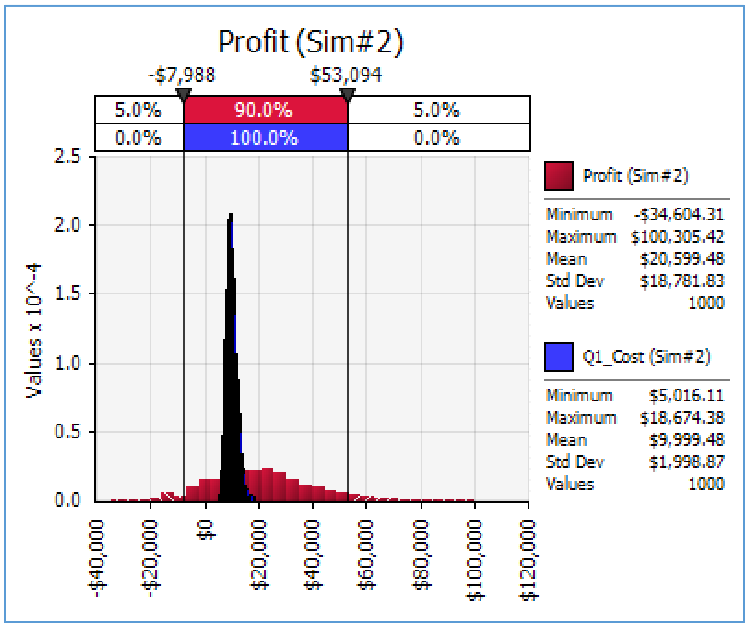
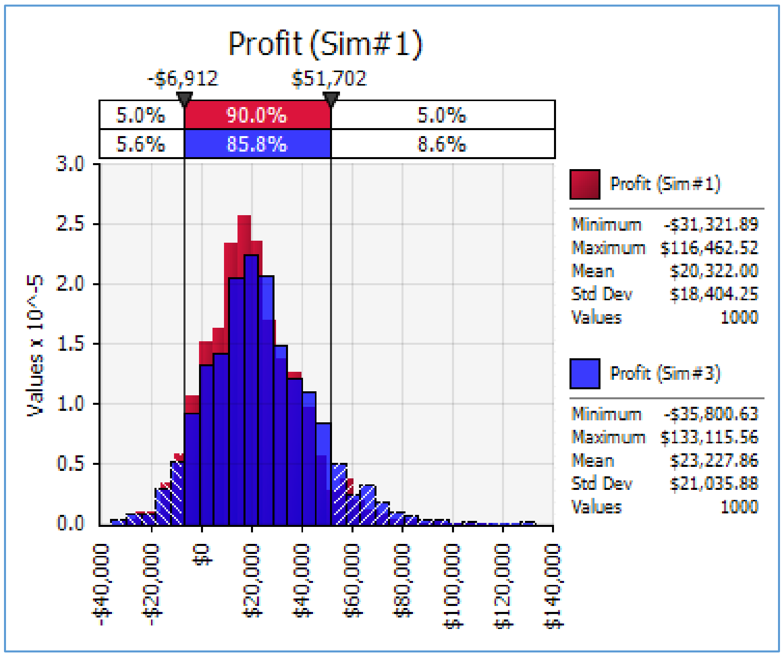


Figure 9 Graph of Profit Distribution for Simulations #1 and #3



GraphSummaryBoxPlot/GraphSummaryTrend Functions

The GraphSummaryBoxPlot/GraphSummaryTrend functions are usually used to graph a time series of outputs, such as monthly cash flows. Their arguments include a reference to the output range and an optional simulation index. This last argument can be an array of simulation indexes, in which case the curves are shown side-by-side. The following code generates the summary trend graph in Figure 10 for the cash flows from simulation #3.

```
Sub GraphSummary_Trend()
    Risk.Simulation.Start
    With Risk.Simulation.Results.GraphSummaryTrend(Range("Cash_Flow"), 3)
        .ImageToWorksheet ActiveSheet, RiskImageFormat_BMP, 10, 300, 300, 250
    End With
End Sub
```

Similarly, the following code generates the summary box plot in Figure 11.

```
Sub GraphSummary_BoxPlot()
    Risk.Simulation.Start
    With Risk.Simulation.Results.GraphSummaryBoxPlot(Range("Cash_Flow"), 3)
        .ImageToWorksheet ActiveSheet, RiskImageFormat_PNG, 10, 300, 300, 250
    End With
End Sub
```

Figure 10 Summary Trend Graph of Cash Flows for Simulation #3

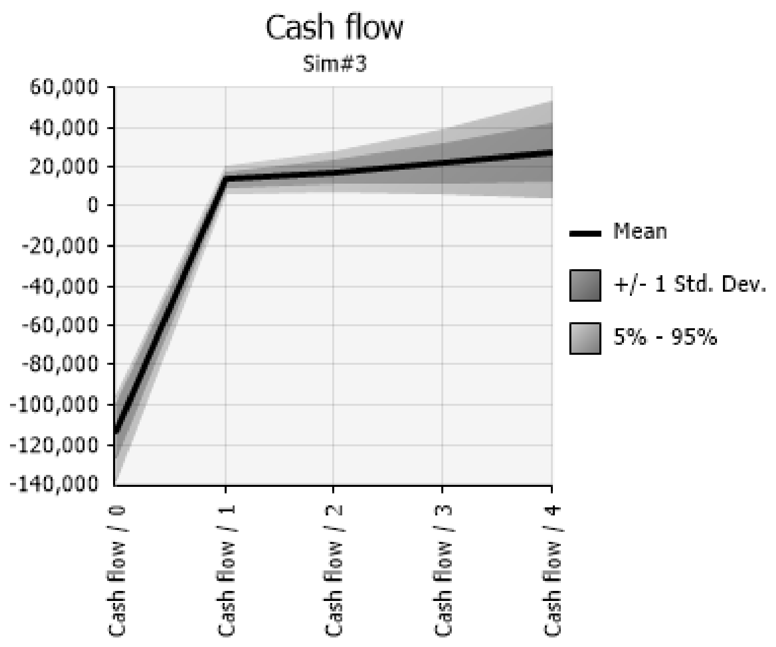
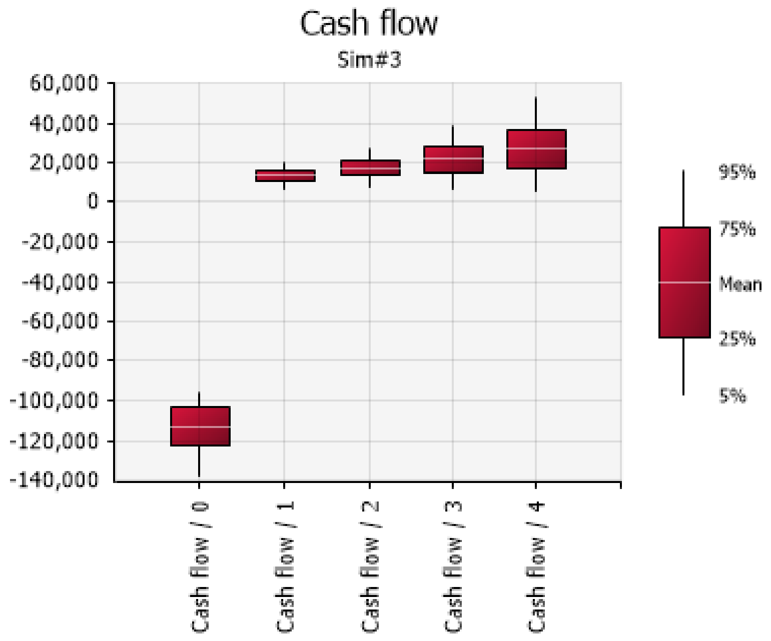


Figure 11 Summary Box Plot of Cash Flows for Simulation #3



GraphScatter Function

The GraphScatter function returns a scatter graph. It requires at least two arguments, the first for the X-axis and the second for the Y-axis, and an optional third argument equal to a *single* simulation index (an array isn't allowed). Each of the first two arguments can be an output, an input, or an array of outputs and/or inputs. (Note that if you try to create a scatter graph of a variable versus itself, you will get an empty graph.) Here is a simple example of the Profit output versus the Q1_Cost input. It results in the graph in Figure 12.

```
Sub GraphScatter_OneScatter()
    Risk.Simulation.Start
    With Risk.Simulation.Results.GraphScatter("Q1_Cost", "Profit")
        .ImageToWorksheet ActiveSheet, RiskImageFormat_PNG, 10, 300, 300, 250
    End With
End Sub
```

The following code creates two scatters (in the same graph) for simulation #2, as shown in Figure 13. The first is of Profit versus Q1_Cost, and the second is of Profit versus Q1_Revenue.

```
Sub GraphScatter_TwoScatters()
    Risk.Simulation.Start
    With Risk.Simulation.Results.GraphScatter(Array("Q1_Cost", "Q1_Revenue"), "Profit", 2)
        .ImageToWorksheet ActiveSheet, RiskImageFormat_PNG, 10, 300, 300, 250
    End With
End Sub
```

Figure 12 Scatter Graph of Profit versus Q1_Cost

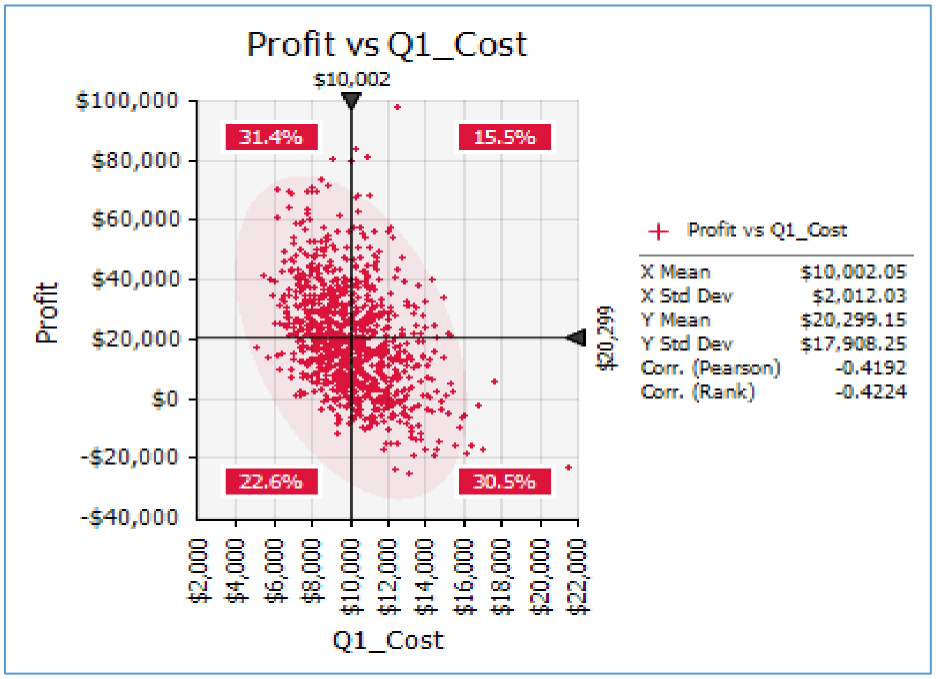
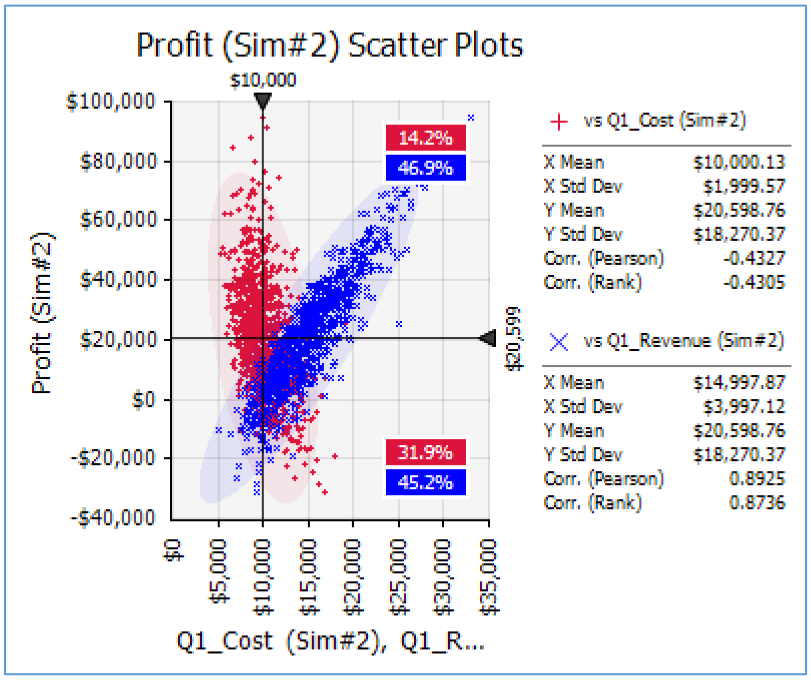


Figure 13 Scatters of Profit versus Q1_Cost and Profit versus Q1_Revenue for Simulation #2



GraphSensitivityTornado Function

The GraphSensitivityTornado function returns a tornado graph, which is used to see how sensitive an output is to the inputs. It has two required arguments, a reference to an output and a RiskSensitivitySettings object. Among the RiskSensitivitySettings properties is the CalculationMethod: for example, we can calculate sensitivities using correlation coefficients or regression coefficients.

The following code generates a tornado graph for the Net Present Value using the "RiskSensitivityTornadoFormat_ChangeInOutputStatistic" calculation method with a maximum of 4 bars, as shown in Figure 14. To get any of the other tornado types, you simply change the second argument to one of the constants listed above.

```
Sub GraphTornado_ChangeInMean()
      Risk.Simulation.Start
      Dim sensSettings As New RiskSensitivitySettings
      sensSettings.CalculationMethod = RiskSensitivityTornadoFormat_ChangeInOutputStatistic
      sensSettings.GraphMaxTornadoBars = 4
      With Risk.Simulation.Results.GraphSensitivityTornado("NPV", sensSettings)
        .ImageToWorksheet ActiveSheet, RiskImageFormat_PNG, 10, 300, 300, 250
      End With
End Sub
```

GraphSensitivitySpider Function

The GraphSensitivitySpider function returns a spider graph, another type of graph for seeing how sensitive an output is to the inputs. It has only one required argument, a reference to the output.

The following code generates a spider graph for Profit with a maximum of 4 lines, as shown in Figure 15.

```
Sub GraphSpider()
      Risk.Simulation.Start
      Dim sensSettings As New RiskSensitivitySettings
      sensSettings.GraphMaxSpiderLines = 4
      With Risk.Simulation.Results.GraphSensitivitySpider("NPV", sensSettings)
         .ImageToWorksheet ActiveSheet, RiskImageFormat_PNG, 10, 300, 300, 250
      End With
End Sub
```

Figure 14 Tornado Graph for NPV

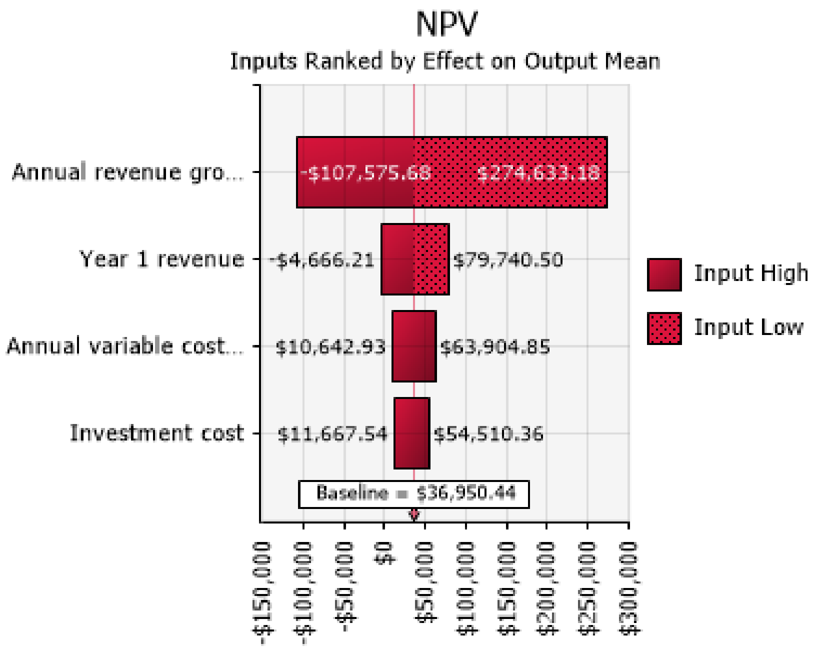
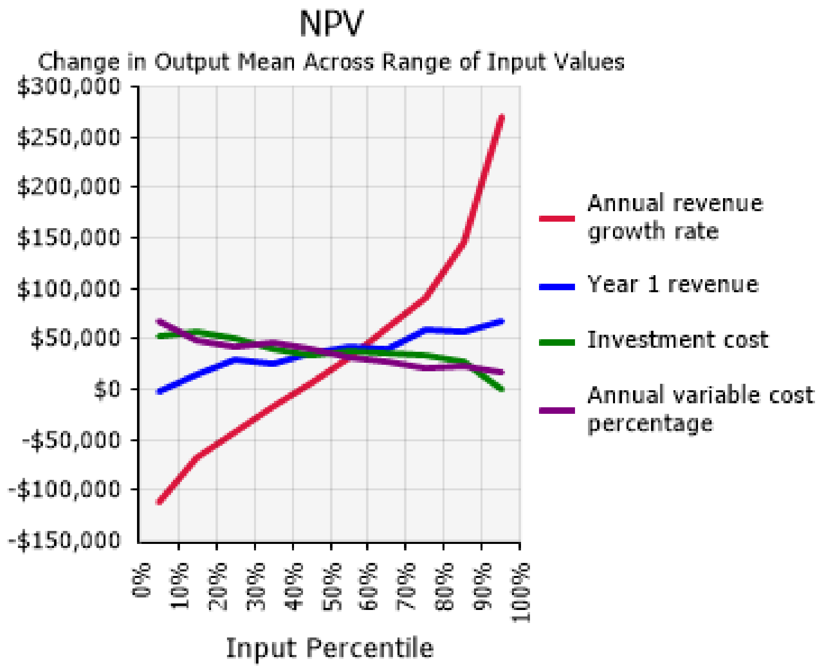


Figure 15 Spider Graph for NPV



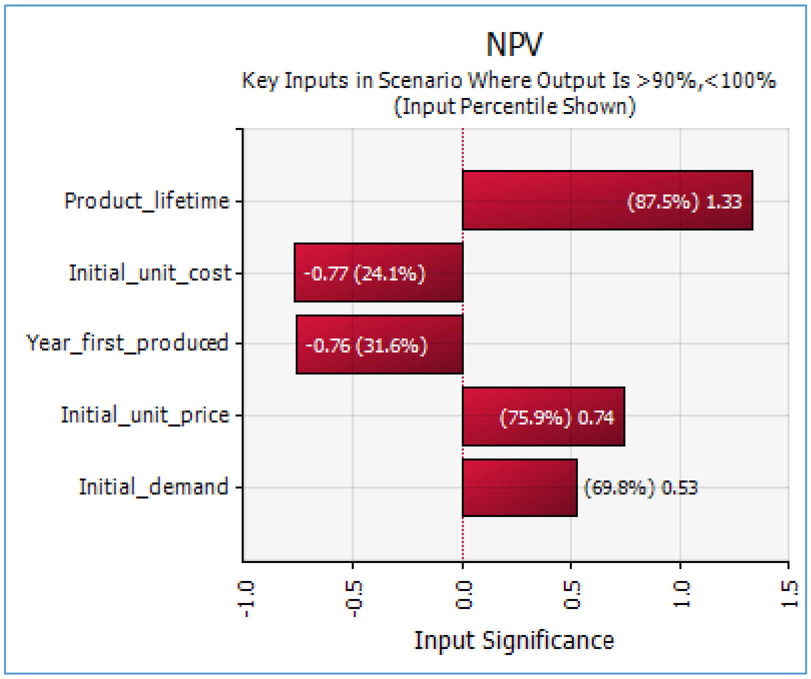
GraphScenarioTornado Function

The GraphScenarioTornado function returns a type of tornado graph for seeing which inputs are most responsible for an output scenario. A typical example appears in Figure 16. The scenario is that the NPV output is greater than its 90th percentile, and the question is which inputs are most responsible (in the sense of being at their extremes) for these large NPV values. As you can see, the Product_lifetime input is at the top of the list. Its “subset median,” the median of its values in the subset of iterations where the scenario occurs, is at the 87.5th percentile of the median of this input for *all* iterations. The other number listed, 1.33, is the difference between the input’s subset median and its overall median, divided by the standard deviation of the input for all iterations. In other words, the input’s subset median for the scenario is 1.33 standard deviations above its overall median.

The function has four required arguments: (1) a reference to the output, (2) a minimum scenario value, (3) a maximum scenario value, (4) whether the minimum and maximum values are percentiles (as opposed to actual values. The following code is typical and leads to the graph in Figure 16.

```
Sub GraphScenarioTornado()
    Risk.Simulation.Start
    With Risk.Simulation.Results.GraphScenarioTornado("NPV", 0.9, 1, True)
        .ImageToWorksheet ActiveSheet, RiskImageFormat_PNG, 10, 300, 300, 250
    End With
End Sub
```

Figure 16 Scenario Tornado Graph for NPV



Creating Reports

The standard @RISK reports found on the ribbon can also be created using code. The options available in the dialogs used to generate reports are also available in code. The code below will make a report showing all the outputs, save it to the specified location as a PDF file, and open the file.

```
   With Risk.Simulation
      ' Generate a report using one of the built-in formats.
      ' Select to make it a PDF file on the desktop and to open it for the user to view.
      .Results.Reports.CreateOutputReport RiskReportOutputsSubType_CompactOutput, _
                            RiskDistributionDisplayFormat_ProbabilityDensity, _
                            RiskReportDestinationType_PDF, _
                            "C:\Users\John\Desktop\AtRiskXDKReport.pdf", _
                            True
End With
```

Listing Inputs and Outputs, and Graphing Input Distributions

It is sometimes handy to list of all @RISK inputs and outputs in a worksheet. You can do this in VBA with **Risk.Model**, as shown in the following code:

```
Sub ListInputsOutputs()

    Dim i As Long
    Dim left As Long, top As Long, width As Long, height As Long
    Dim modelDefinition As RiskModelDefinition
    Dim modelInput As RiskModelDefinitionInput
    Dim modelOutput As RiskModelDefinitionOutput

    'Storing reference to this object in a variable is optional.
    'Passing True as the parameter will cause the workbooks to be rescanned for changes;
    'this will ensure that the information is up-to-date, reflecting the latest
    'changes made by the user.
    'Pass False for performance reasons, if you know changes have not occurred.
    Set modelDefinition = Risk.Model.GetModelDefinition(True)

   ' Create worksheet where we will write the information about inputs and outputs.
    Dim wsInputsOutputs As Excel.Worksheet
    Set wsInputsOutputs = ActiveWorkbook.Worksheets.Add()

    ' Write information about all input functions
    With wsInputsOutputs.Range("B3")
        For i = 1 To modelDefinition.ModelInputs.Count
            Set modelInput = modelDefinition.ModelInputs.Item(i)
            .Offset(i, 0).Value = i
            .Offset(i, 1).Value = modelInput.Location.Worksheet.Name
            .Offset(i, 2).Value = modelInput.Location.Address
            .Offset(i, 3).Value = modelInput.RiskFunction
            .Offset(i, 4).Value = modelInput.Name
        Next
    End With

    ' Write information about all output functions
    With wsInputsOutputs.Range("H3")
        For i = 1 To modelDefinition.ModelOutputs.Count
            .Offset(i, 0).Value = i
            Set modelOutput = modelDefinition.ModelOutputs.Item(i)
            .Offset(i, 1).Value = modelOutput.Location.Worksheet.Name
            .Offset(i, 2).Value = modelOutput.Location.Address
            .Offset(i, 3).Value = modelOutput.RiskFunction
            .Offset(i, 4).Value = modelOutput.Name
        Next
    End With

    ' Graph theoretical input distributions
    left = 10: top = 125: width = 300: height = 250
    With Risk.Model
        For i = 1 To modelDefinition.ModelInputs.Count
            With .GraphDistribution(modelDefinition.ModelInputs.Item(i).Location)
                .ImageToWorksheet wsInputsOutputs, RiskImageFormat_BMP, left, top, width, height
            End With
            If i < modelDefinition.ModelInputs.Count Then left = left + width + 5
        Next
    End With

    wsInputsOutputs.Activate
End Sub
```

This code also illustrates another graph option, the **GraphDistribution** method of the RiskModel object. (Don't confuse this with the GraphDistribution function for simulated results discussed earlier). This allows you to create the graph of a *theoretical* input distribution. Its argument can be a range, as in the above code, an @RISK distribution function such as RiskNormal(100,10), or an array of these (for an overlay).

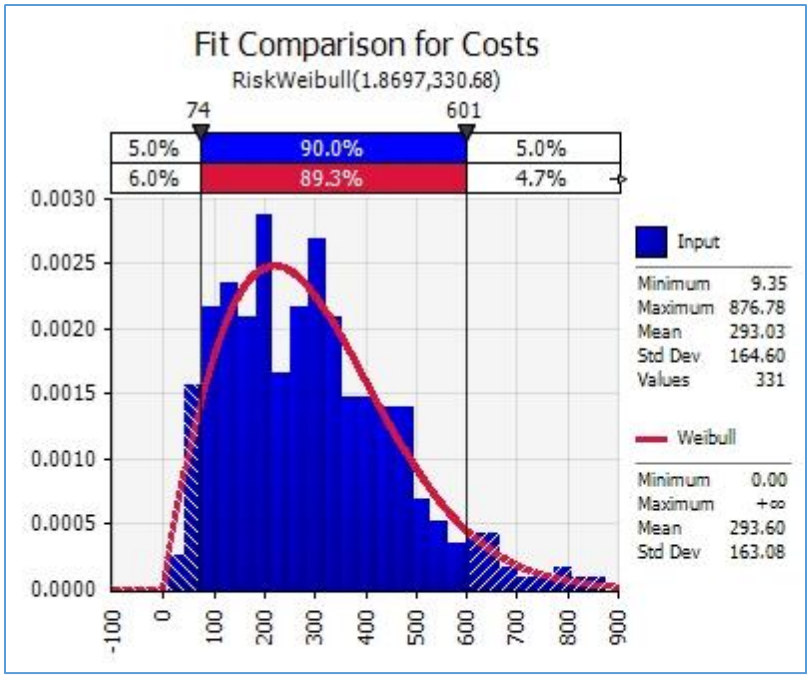
Fitting Distributions to Data

If you have used @RISK's fitting tools, either for fitting to a single column of data or for batch fitting to several columns of data, you know that this can be done through the @RISK user interface with only a few mouse clicks. However, this user interface has a *lot* of settings you can change, and this leads to a fairly complex set of objects for fitting in the @RISK object model.

The following code illustrates the most basic features. This fits nonnegative distributions to historical cost data. It first creates a fit definition and sets some of its properties. Then it performs the fitting, it lists several summary statistics of the data, and it lists several summary statistics and graphs of the best-fitting distribution. For example, the GraphFitComparison function creates the graph in Figure 17. This shows the best-fitting distribution superimposed on the histogram of the cost data.

```
Sub FitTest()
    Dim msg As String

    ' Delete graphs if any
    DeleteGraphs wsData

    ' Delete named fit if it already exists
    On Error Resume Next
    Risk.Fits.Item("Costs").Delete

    ' Create fit definition
    With Risk.Fits.Add(Range("Cost_Data"), RiskFitDataType_ContinuousSamples, "Costs")
        .BestFitSelectorStatistic = RiskFitStatistic_AIC
        .LowerLimitType = RiskFitLimitType_Fixed
        .LowerLimitValue = 0
        .UpperLimitType = RiskFitLimitType_Open
        .SuppressQuestionableFits = True

        With .PerformFit
            With .FitInput
                ' Information about data
                msg = "Summary stats of data:" & vbCrLf & vbCrLf
                msg = msg & "Mean: " & Format(.Mean, "#,##0.00") & vbCrLf
                msg = msg & "Std Dev: " & Format(.StdDeviation, "#,##0.00") & vbCrLf
                msg = msg & "5th percentile: " & Format(.PToX(0.05), "#,##0.00") & vbCrLf
                msg = msg & "95th percentile: " & Format(.PToX(0.95), "#,##0.00")
                MsgBox msg
            End With

            With .BestFit(RiskFitStatistic_AIC)
                ' Information about best fit
                msg = "Information about best fit:" & vbCrLf & vbCrLf
                msg = msg & "Distribution: " & .DistributionFunction & vbCrLf
                msg = msg & "Mean: " & Format(.Mean, "#,##0.00") & vbCrLf
                msg = msg & "Std Dev: " & Format(.StdDeviation, "#,##0.00") & vbCrLf
                msg = msg & "5th percentile: " & Format(.PToX(0.05), "#,##0.00") & vbCrLf
                msg = msg & "95th percentile: " & Format(.PToX(0.95), "#,##0.00")
                MsgBox msg

                ' Graphs of best fit
                .GraphFitComparison.ImageToWorksheet wsData, RiskImageFormat_JPG, 100, 50, 300,
250
                .GraphPP.ImageToWorksheet wsData, RiskImageFormat_JPG, 420, 50, 300, 250
                .GraphQQ.ImageToWorksheet wsData, RiskImageFormat_JPG, 740, 50, 300, 250
            End With
        End With
    End With
End Sub
```

Figure 17 Fit Comparison Graph



The following code, is typical for a batch fit. The fit definition is now created with the AddBatch function (not the Add function as above), and the properties of the fit definition now include a few properties that pertain only to batch fits. The code also illustrates how you can restrict the distributions to be fit with the EstimatedFitsSetList function, followed by an array of distribution names.

```
Sub BatchFit()
    Dim distList(1 To 4) As String

    ' Delete named fit if it already exists
    On Error Resume Next
    Risk.Fits.Item("Cost_Fits").Delete

    ' Distributions to try
    distList(1) = "Gamma"
    distList(2) = "LogLogistic"
    distList(3) = "Weibull"
    distList(4) = "Lognorm"

    ' Set up and run a batch fit
    With Risk.Fits.AddBatch(Range("Cost_Data"), RiskFitDataType_ContinuousSamples, "Cost_Fits")
        ' Batch fit properties
        .BatchFitReportIncludeCorrelations = True
        .BatchFitReportIncludeDetailWorksheets = True
        .BatchFitReportInNewWorkbook = False
        .BatchFitReportStyle = RiskBatchFitReportStyle_Standard
        .BestFitSelectorStatistic = RiskFitStatistic_AIC

        ' Try only the distributions in the distList array
        .EstimatedFitsList_SetArray distList
        .PerformFit
    End With
End Sub
```

Programming Tip: Using "Add" in a line "With" line

The above FitTest and BatchFit macros illustrate a very handy VBA programming construction you might have missed, one that you will see throughout the XDK example files. Consider the following line:

```
With Risk.Fits.Add(Range("Cost_Data"), RiskFitDataType_ContinuousSamples, "Costs")
```

This line not only adds an item to a collection—a RiskFitDefinition object to the collection of RiskFitDefinition objects—but it implicitly returns this RiskFitDefinition object so that you can access its properties and methods directly in the With block. As a beginning programmer, you might find it more natural to define an explicit RiskFitDefinition object, "set" it, and then work with the explicit object, as follows:

```
Dim rFit As RiskFitDefinition
Set rFit = Risk.Fits.Add(Range("Cost_Data"), RiskFitDataType_ContinuousSamples, "Costs")
With rFit
```

This is fine, but these three lines are *equivalent* to the single line above, and the latter is more compact. There are indeed times when you will need an explicit object variable (like rFit), so that you can use it later in your code. But if you don't need it, you should consider using the more compact version. By the way, this tip applies to VBA programming for Excel, not just for @RISK.

Creating Filters

The @RISK Filter tool lets you "filter out" results that don't meet certain conditions. There are two types of filters, standard and iteration. A standard filter is useful when we want to look at only those values of an output that satisfy a certain condition. For example, the following code adds a standard filter on an output named "NPV" (for Net Present Value) output. The filter conditions are essentially that NPV is negative, and the resulting graph appears in Figure 18. As in the @RISK user interface for filters, you must first "do" something, usually add one or more filters or clear the filters, and apply the changes. For example, if the .Clear line were not followed by the .ApplyChanges line, the filters in effect wouldn't be cleared; they would still be in effect.

```
Sub FilterTest_Standard()
    With Risk.Simulation
        ' Run simulation
        .Start

        With .Results
            ' Add standard filter to the Net Present Value output.
            With .Filters
                .Add "NPV", RiskFilterType_Standard, RiskNegativeInfinity, 0, False
                .ApplyChanges
            End With

            With .GraphDistribution("NPV")
                .TitleMainText = "NPV Distribution, Negative Values Only"
                .ImageToWorksheet ActiveSheet, RiskImageFormat_PNG, 320, 245, 300, 250
            End With

            With .Filters
                .Clear
                .ApplyChanges
            End With
        End With
    End With
End Sub
```

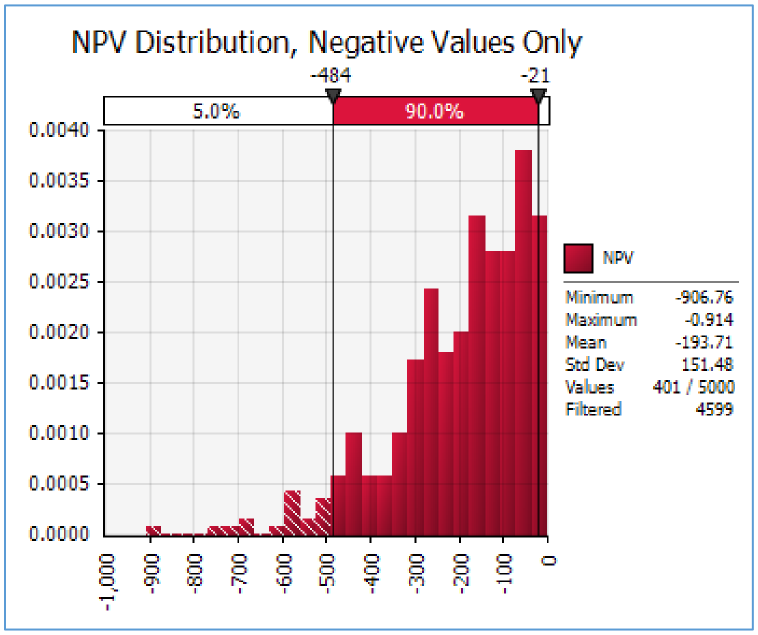
The key to this code is the Add line. This adds a filter to the collection of filters currently in effect. Its arguments are a reference to an output (or input), the type of filter (standard or iteration), minimum and maximum values, and whether these are actual values or percentiles. If you wanted the values to be percentiles, you could change the Add line to something like the following.

```
.Add "NPV", RiskFilterType_Standard, 0.25, 0.75, True
```

Technical Note: Infinity Constants

Note that the filter on NPV in the above code is really “less than or equal to 0.” However, both a lower bound and an upper bound are required when adding this filter. For the lower bound, you can use @RISK’s built-in constant RiskNegativeInfinity. A RiskPositiveInfinity constant is also available.

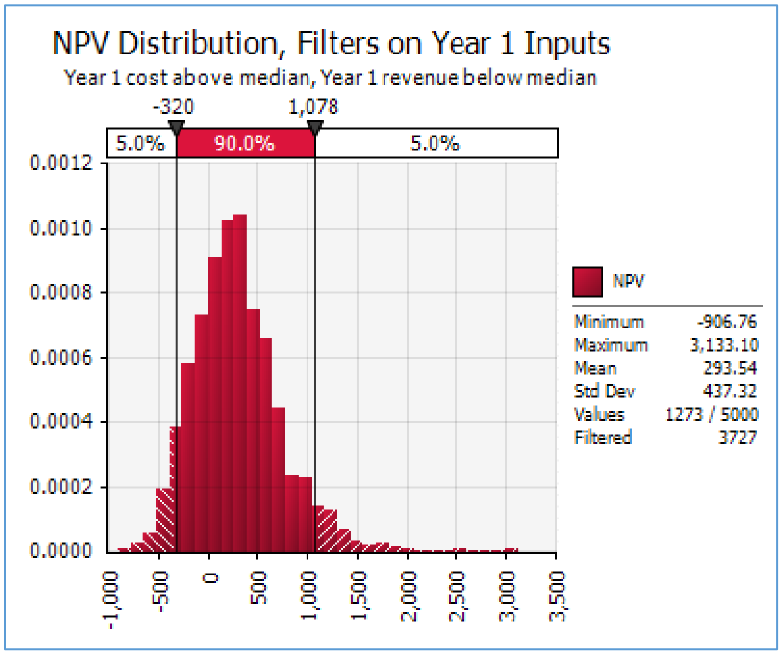
Figure 18 Graph of an Output with a Standard Filter



The VBA code for an iteration filter is virtually identical, as shown below, with the resulting graph in Figure 19. However, it is important to understand what it is doing. In this example, two iteration filters are added: one where the year 1 cost input is above its median and one where the year 1 revenue input is below its median. Each iteration where *both* of these conditions hold is “marked,” and the requested graph for the NPV output uses only the marked iterations—in this case, about 25% of them. It turns out that the unfiltered mean NPV for this model is about 800. Obviously, the filtered mean is much lower.

```
Sub FilterTest_Iteration()
    With Risk.Simulation
        ' Run simulation
        .Start

        With .Results
            ' Add iteration filters to outputs
            With .Filters
                .Add "Year1_Cost", RiskFilterType_Iteration, 0.5, 1, True
                .Add "Year1_Revenue", RiskFilterType_Iteration, 0, 0.5, True
                .ApplyChanges
            End With

            With .GraphDistribution("NPV")
                .TitleMainText = "NPV Distribution, Filters on Year 1 Inputs"
                .TitleDescriptionText = "Year 1 cost above median, Year 1 revenue below median"
                .ImageToWorksheet ActiveSheet, RiskImageFormat_PNG, 320, 245, 300, 250
            End With

            With .Filters
                .Clear
                .ApplyChanges
            End With
        End With
    End With
End Sub
```

Figure 19 Graph of an Output with an Iteration Filter on Two Inputs



Goal Seek Analysis

The Goal Seek tool in @RISK is similar to the Goal Seek tool in Excel, which forces the value of a formula to a specified value by changing the value in an “adjustable cell.” @RISK’s Goal Seek tool is more flexible because it lets you force a *summary measure* of an output, such as the mean, the standard deviation, or a percentile, to a specified value.

The following code illustrates the basic possibilities. From Risk.Simulation, you first create a new Goal Seek analysis with the NewGoalSeekAnalysis function. Then you specify the adjustable cell (VariationCell), the output cell, the type of output statistic, and required values. You can set the number of iterations to any value, but because several simulations will be run to “sneak up on” the best value of the adjustable cell, a very big number of iterations may result in an unacceptable runtime. Then you use the RunAnalysis function to run Goal Seek. This function returns True if a solution is found and False otherwise, so an error check should be included. For example, there might not be *any* value of the cost factor that makes the 25th percentile of NPV equal to 800.

```
Sub RunGoalSeek()
    ' Create new Goal Seek analysis
    With Risk.Simulation.NewGoalSeekAnalysis()
        ' Goal Seek settings
        Set .VariationCell = Range("Cost_Factor")
        Set .OutputCell = Range("NPV")
        .OutputStatistic = RiskStatisticType_Percentile
        .OutputPercentile = 0.25
        .OutputTarget = 800

        ' Small number of iterations for Goal Seek
        Risk.Simulation.Settings.NumIterations = 500

        ' Run Goal Seek and check if a solution is found
        If Not .RunAnalysis() Then
            MsgBox "Goal Seek couldn't find a solution.", vbInformation
            Exit Sub
        Else
            MsgBox "Cost factor that makes 25th percentile of NPV equal to 800 = " _
                & Format(Range("Cost_Factor").Value, "#,##0.000")
        End If
    End With
End Sub
```

Advanced Sensitivity Analysis

The @RISK Advanced Sensitivity Analysis tool provides more sensitivity options than the usual tornado or spider graphs. For example, it allows you to perform sensitivity analysis on fixed inputs, not just on inputs with distribution functions.

The following code is typical. It is fairly long but straightforward. From Risk.Simulation, you use the NewAdvSensitivityAnalysis function to create a new advanced sensitivity analysis. Next, you specify an output and an output statistic to monitor, and you specify as many inputs as you like. In this example, the first input is a fixed value and the other four are distributions. After that, you specify how you want the inputs to vary. In this example, the fixed input varies from 0.05 to 0.15 in 5 steps, with a base value of 0.1. The distribution-based inputs also vary over 5 steps, but they use their 10th, 25th, 50th, 75th, and 90th percentiles for varying. (Note how the VariationPercentiles_SetArray function takes an array as its argument. This explains why the percent array is created.) Finally, you specify the report placement and the reports you want, and you run the analysis with the RunAnalysis function.

```
Sub AdvSensAnalysisTest()
    Dim inputCellBased As RiskAdvSensInput
    Dim inputDistBased(1 To 4) As RiskAdvSensInput
    Dim percent(1 To 5) As Double
    Dim i As Integer

    ' Specify output and inputs
    With Risk.Simulation.NewAdvSensitivityAnalysis
        ' Output to analyze
        Set .OutputCell = Range("NPV")
        .OutputStatistic = RiskStatisticType_Mean

        ' Input that isn't a distribution
        Set inputCellBased = .Inputs.Add(RiskAdvSensInputType_CellBasedInput, _
             Range("Discount_Rate"))

        ' Properties of cell-based input
        With inputCellBased
            .VariationMethod = RiskAdvSensVariationMethod_MinMaxRange
            .BaseValue = 0.1
            .VariationMinimum = 0.05
            .VariationMaximum = 0.15
            .VariationNumSteps = 5
        End With

        ' Inputs that are distributions
        Set inputDistBased(1) = .Inputs.Add _
            (RiskAdvSensInputType_DistributionBasedInput, Range("Fixed_Cost"))
        Set inputDistBased(2) = .Inputs.Add _
            (RiskAdvSensInputType_DistributionBasedInput, Range("Revenue_Year1"))
        Set inputDistBased(3) = .Inputs.Add _
            (RiskAdvSensInputType_DistributionBasedInput, Range("Annual_Revenue_Change"))
        Set inputDistBased(4) = .Inputs.Add _
            (RiskAdvSensInputType_DistributionBasedInput, Range("Variable_Cost_Percentage"))

        ' Percentages used in variation of distribution-based inputs
        percent(1) = 0.1:percent(2) = 0.25:percent(3) = 0.5:percent(4) = 0.75:percent(5) = 0.9
        For i = 1 To 4
            With inputDistBased(i)
                .VariationMethod = RiskAdvSensVariationMethod_DistributionPercentiles
                .VariationPercentiles_SetArray percent
            End With
        Next

        ' ReportPlacement
        .ReportPlacement = RiskExcelReportPlacement_ActiveWorkbook

        ' Reports to include
        .IncludeSummaryReport = True
        .IncludePercentilesGraph = False
        .IncludeBoxWhiskerPlot = False
        .IncludePercentChangeGraph = True
        .IncludeTornadoDiagram = True

        ' Run sensitivity analysis
        .RunAnalysis
    End With
End Sub
```

Stress Analysis

@RISK's Stress Analysis tool allows you to compare the results from a "base" model to one where one or more inputs are "stressed," that is, where the values of these inputs are sampled from conditional probability distributions instead of the original distributions.

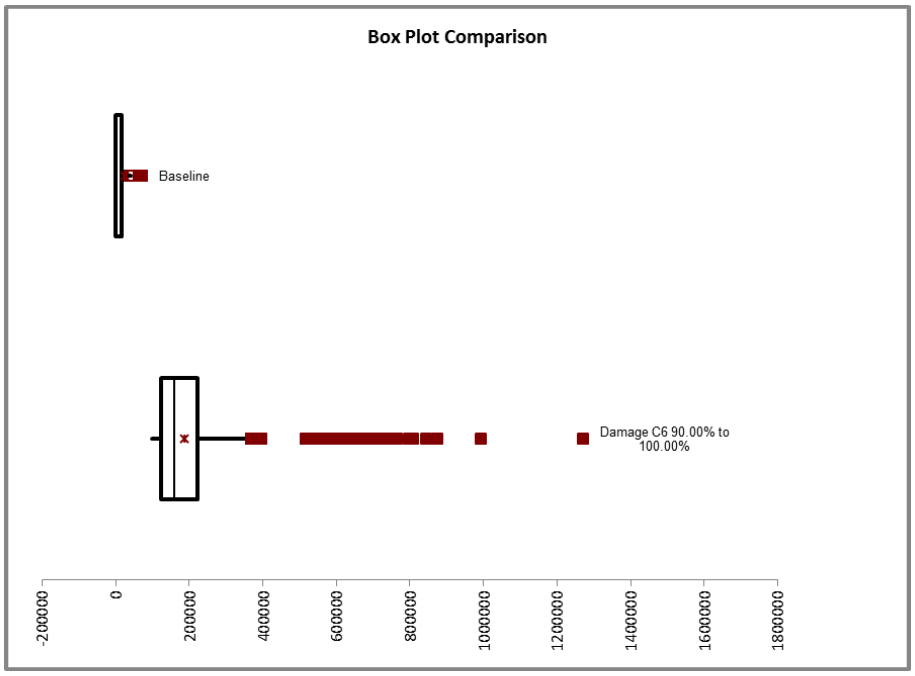
The following code illustrates a typical stress analysis. It is in an insurance context, where the input is the random Damage and the output is the loss to the insurance company, assuming a deductible amount near the 70th percentile of the damage distribution. (Any other deductible amount could be used.) The insurance company wants to see the distribution of its loss when really large damages occur. Starting with Risk.Simulation, you create a new stress analysis with the NewStressAnalysis function. Next, you add one or more inputs and specify their parameters. In this example, the Damage input is constrained to be above its 90th percentile, so that the stress analysis will sample damages from the top 10 percent of the damage distribution. Then you specify the output cell to monitor, the report placement, and the desired reports. Finally, you run the analysis with the RunAnalysis function.

```
Sub StressAnalysis()
    ' Create new Stress analysis
    With Risk.Simulation.NewStressAnalysis
```

```
        ' Define input and its parameters
        With .Inputs.Add(Range("Damage"))
            .StressMethod = RiskStressMethod_PercentileRange
            .PercentileMin = 0.9
            .PercentileMax = 1
        End With

        ' Define output
        Set .OutputCell = Range("Insurance_Company_Loss")

        ' Specify report placement and reports, and run analysis
        .ReportPlacement = RiskExcelReportPlacement_ActiveWorkbook
        .IncludeSummaryReport = True
        .IncludeComparisonGraphs = True
        .RunAnalysis
    End With
End Sub
```

One of the resulting graphs from this analysis appears in Figure 20. It shows the distribution of the loss to the insurance company for the original baseline model and the model with stressing. Obviously, the losses in the latter tend to be considerably larger. In the baseline model, the company pays nothing about 70% of the time, and it pays a positive amount 30% of the time. In the stressed model, the insurance company *always* pays.

Figure 20 Box Plots of Insurance Company Losses for Baseline and Stressed Version



Automating RISKOptimizer

RISKOptimizer is totally integrated into @RISK. Nevertheless, it has its own XDK, with its own object model. For example, the names of most RISKOptimizer objects start with “Opt,” whereas @RISK objects start with “Risk.” When you automate RISKOptimizer with VBA code, you should not only set the usual references to **RiskXLA** and **Palisade_Risk_XDK8**, but you should also set a reference to **Palisade**

RISKOptimizer 8.x for Excel Developer Kit. (In the Object Browser, this library is abbreviated as **RiskOptOL8**.)

There are plenty of objects, properties, and methods in the RISKOptimizer Object Model, but the "flow" is fairly straightforward. You start with the "root" object **RiskOptimizerRoot**. Actually, you can simply type **RiskOptimizer** to reference this root object. (Technically, RiskOptimizer is a function from RiskXLA that returns a RiskOptimizerRoot object.) Then you create an **OptModelWorkbook** object, and from it, you define the goal, the adjustable cells groups, the constraints, and the optimization settings. Finally, after optimizing with the line **RiskOptimizer.Optimize**, you can report optimization results.

The following code is typical. Here are the basic steps.

1. It uses the outer With block to create the OptModelWorkbook object (implicitly).
2. It specifies that the goal is to maximize the 5th percentile of the Ending_Value output.
3. It removes any previous adjustable cell groups and constraints, just in case.
4. It adds an adjustable cell group of the budget type. The range for this cell group is the Investment_Weights range, its lower and upper limits are in the Min_Weights and Max_Weights ranges, respectively, the next three optional arguments are omitted, and the last optional argument indicates a step size of 0.005 for a discrete search.
5. It adds a hard constraint that should be enforced on each iteration. The arguments indicate that the "APPL_CSCO_Pct" range should be within minimum and maximum values.
6. It changes some optimization settings.
7. It changes some simulation settings.
8. It runs the optimization and reports some results.

```
Sub RunRiskOptimizer()
    Dim msg As String

    ' Optimization Model
    With RISKOptimizer.ModelWorkbook(ActiveWorkbook)
        ' Goal
        With .Goal
            Set .CellToOptimize = Range("Ending_Value")
            .StatisticToOptimize = OptStatisticPercentile
            .StatisticParameter = 0.05
            .GoalType = OptGoalMaximize
        End With

        ' Remove adjustable cells and constraints if any
        .AdjustableCellGroups.RemoveAll
        .Constraints.RemoveAll

        ' Add budget adjustable cell group
        .AdjustableCellGroups.AddWithBudgetSolvingMethod.AdjustableCellRanges _
            .AddForBudgetSolvingMethod Range("Investment_Weights"), _
            Range("Min_Weights"), Range("Max_Weights"), , , , 0.005

        ' Constraint (just for illustration)
        .Constraints.AddHardInSimpleMode OptEvaluationEachIteration, _
            Range("Min_APPL_CSCO"), OptLessOrEqual, Range("APPL_CSCO_Pct"), OptStatisticValue, _
            0, OptLessOrEqual, Range("Max_APPL_CSCO"), "Limits for APPL plus CSCO"

        ' Optimization settings
        With .OptimizationSettings
            .Engine.OptimizationEngine = OptEngineAutomatic
            .Runtime.TrialCountStoppingCondition = True
            .Runtime.trialCount = 1000
        End With
        ' Simulation settings
        With Risk.Simulation.Settings
            .NumIterations = 100
            .AutomaticResultsDisplay = RiskAutomaticResultsDisplay_NoAutomaticResults
        End With

        ' Run optimization
        RISKOptimizer.Optimize

        ' Report selected results
        With .OptimizationResults
            msg = "Time to optimize (seconds): " _
                & Format((.FinishTime - .StartTime) * 24 * 60 * 60, "#,#00.0")
            msg = msg & vbCrLf & "Best result: " & Format(.BestValueWithoutPenalties, "$#,#00")
        End With
        MsgBox msg
    End With
End Sub
```

You can also use the RISKOptimizer XDK inside macros to obtain information about an optimization in progress and control it, even if the model is set up and the optimization is started through the graphical interface, not through VBA. For example, the following macro will stop the optimization if there is no progress after 100 trials. (To ensure that this macro is called during the optimization, you need to specify its name in the Macros tab of the Optimization Settings dialog).

```
Sub MyAfterStorageRoutine()
   With RISKOptimizer.ModelWorkbook(ActiveWorkbook).OptimizationResults
      If .NumTrials >= 100 Then
         If .BestValueWithPenalties = .OriginalValueWithPenalties Then
            RISKOptimizer.OptimizationManager.StopOptimization
         End If
      End If
   End With
End Sub
```

Technical Note: Multiple CPUs

Anytime you have code that runs *in the middle of a simulation* (e.g. a user-defined function or a simulation macro) and uses anything in the @RISK object model, it is a good idea turn off the multiple CPUs option. This can be done through the @RISK user interface: using the Settings button in the Simulation section on the ribbon for regular simulations, or using the Advanced Tab of the Optimization Settings dialog for optimizations; this can also be done via code.

The reason is that when multiple CPUs are used by @RISK, multiple copies of Excel can be launched to run your simulation. Only the original Excel has access to the @RISK object model, and if one of the copies tries to access the Risk object, an error will occur. Keep in mind that this doesn't affect any code you run before or after the simulation. It also isn't an issue if your simulation macro or user-defined function doesn't call anything in the @RISK object library.

Some General VBA Tips

This guide concludes with a few VBA tips that you should know regardless of whether you are automating @RISK or Excel.

File Format (xlsm)

If you save a workbook that includes VBA code, you must save it as a macro-enabled (.xlsm) file. This is true for any Excel file that contains VBA code; it is not specific to @RISK files. Then if you open this .xlsm file later on, you will be warned that it contains macros. Make sure you elect to enable the macros; otherwise the VBA macros won't work.

Running a Macro

If you develop a VBA program for nontechnical users, you probably won't want them to see your code, either for proprietary reasons or because it would be too intimidating. However, it is easy to create a simple user interface for running the program. To do so, activate a worksheet, insert a shape such as a rectangle, right-click it, select **Assign Macro**, and select your macro. You can also insert descriptive text, such as **Run Program,** in the shape. From then on, a user can simply click the shape to run the program.

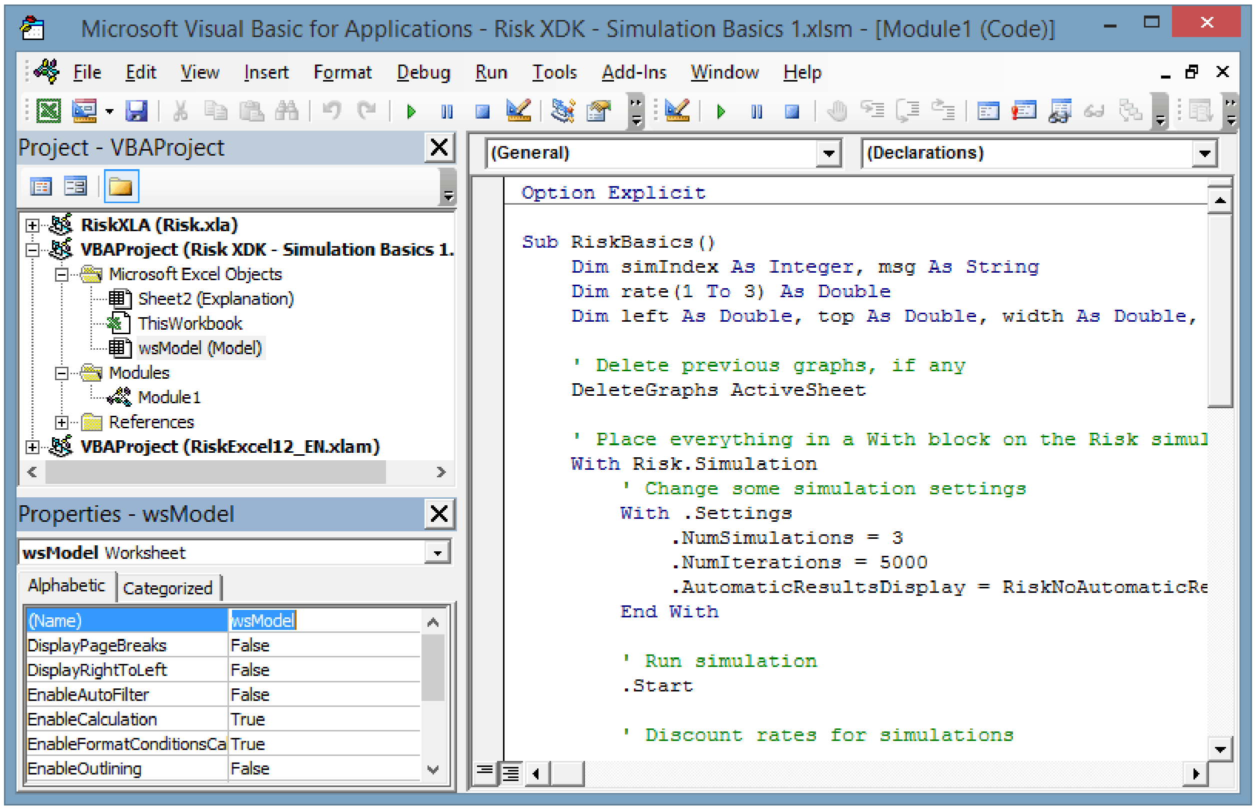
ThisWorkbook

You can always reference a workbook by name, as in Workbooks("My Example File.xlsm"). Alternatively, you can refer to the *active* workbook with the built-in object **ActiveWorkbook**. However, an even safer reference is to **ThisWorkbook**, which always references the workbook containing the VBA code. (It is safer than ActiveWorkbook because the workbook containing the code might not be active when you run your program.)

Worksheet Code Names

The code in the example files sometimes references worksheets by their "code" names. A worksheet actually has two names, the name you see on its tab, and a code name, which can be set only in the Visual Basic Editor. This is illustrated in Figure 21 (see the highlighted line in the Properties section). In this example, the notation wsModel (Model) in the Project section indicates that Model is the name on the tab and wsModel is the code name. (Any names can be used for code names, but a common practice is to use the prefix ws.) One reason for using code names in VBA programs is that you don't need to create a Worksheet object variable; you can simply write wsModel.Range("A1"), for example. A second reason is that if your code refers to the worksheet by name, as in Worksheets("Model"), and someone changes the name on the worksheet tab, an innocent enough change to make, this will break your program. However, because code names can be changed only through the Visual Basic Editor, it is much less likely that anyone will change them.

Figure 21 Code Name for Worksheet


Microsoft Visual Basic for Applications - Risk XDK - Simulation Basics 1.xlsm - [Module1 (Code)]
File Edit View Insert Format Debug Run Tools Add-Ins Window Help
Project - VBAProject
RiskXLA (Risk.xla)
VBAProject (Risk XDK - Simulation Basics 1.
Microsoft Excel Objects
Sheet2 (Explanation)
ThisWorkbook
wsModel (Model)
Modules
Module1
References
VBAProject (RiskExcel12_EN.xlam)
Properties - wsModel
wsModel Worksheet
Alphabetic
Categorized
(General)
(Declarations)

(Name)	wsModel
DisplayPageBreaks	False
DisplayRightToLeft	False
EnableAutoFilter	False
EnableCalculation	True
EnableFormatConditionsCa	True
EnableOutlining	False

```
Option Explicit

Sub RiskBasics()
    Dim simIndex As Integer, msg As String
    Dim rate(1 To 3) As Double
    Dim left As Double, top As Double, width As Double,

    ' Delete previous graphs, if any
    DeleteGraphs ActiveSheet

    ' Place everything in a With block on the Risk simul
    With Risk.Simulation
        ' Change some simulation settings
        With .Settings
            .NumSimulations = 3
            .NumIterations = 5000
            .AutomaticResultsDisplay = RiskNoAutomaticRe
        End With

        ' Run simulation
        .Start

        ' Discount rates for simulations
```

With Blocks

In the XDK example files, you will see a lot of **With** blocks, sections that start with the keyword With and end with the keyword End With. These are used by all good VBA programmers, so you should get used to them. They allow you to avoid a lot of repetitive code, as illustrated by the following block of code. Inside the **With Risk.Simulation** block, anything that starts with a period really has **Risk.Simulation** to the left of it. For example, **. Settings** is equivalent to **Risk.Simulation.Settings**. As you can see, these With blocks can be nested to avoid even more repetitive code. For example, **.NumSimulations** is equivalent to **Risk.Simulation.Settings.NumSimulations**. It is a *very* good idea to indent these blocks appropriately, as has been done here, for easier reading.

```
    With Risk.Simulation
        ' Change some simulation settings
        With .Settings
            .NumSimulations = 3
            .NumIterations = 5000
            .AutomaticResultsDisplay = RiskAutomaticResultsDisplay_NoAutomaticResults
        End With
    End With
```

Intellisense

The reference to the @RISK library mentioned earlier is not only required to make your @RISK code work properly, but it provides you with an invaluable programming aid: Intellisense. As an example, consider the following line:

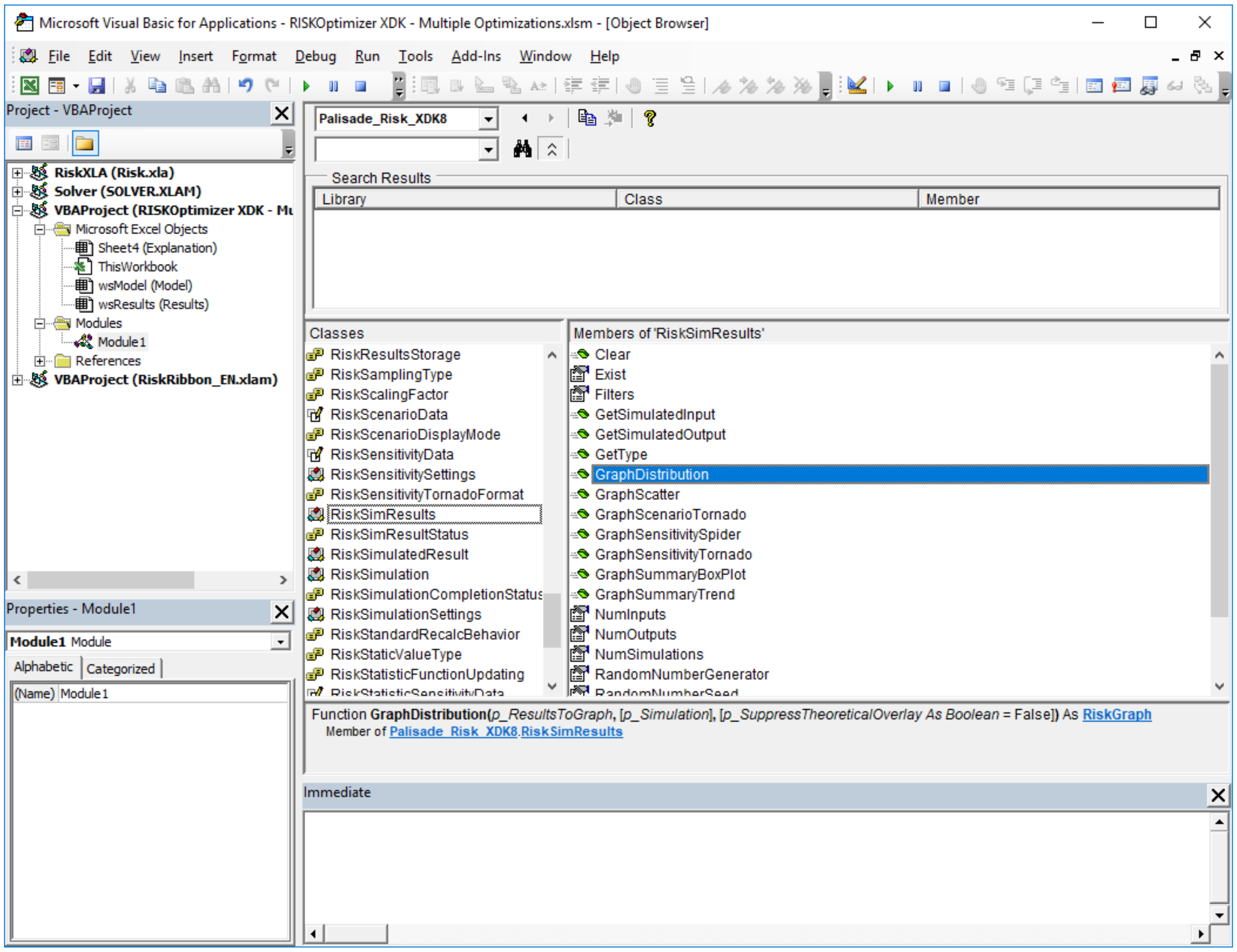
```
Risk.Simulation.Settings.AutomaticResultsDisplay = RiskAutomaticResultsDisplay_NoAutomaticResults
```

Could you remember all of this? Fortunately, you don't have to. As soon as you type **Risk.** (including the period), you will see a list you can choose from. Then when you choose **Simulation** from the list and type a period, you will see another list to choose from. And so on. To cap it off, when you have entered everything to the left of the equals sign and then type the equals sign, you will see a list of the appropriate @RISK constants for the AutomaticResultsDisplay property that you can choose from. If you are already an Excel programmer, you undoubtedly appreciate the power of Intellisense, and you will be happy to know that it extends to VBA for @RISK. If you are not yet familiar with Intellisense, you are in for a big treat!

Object Browser

A great source of information is the VBA Object Browser. To see this, make sure a file with a reference to the @RISK library is selected in Project pane. Then select Palisade_Risk_XDK8 from the libraries dropdown list. This Object Browser shows all of the @RISK objects on the left and all of their properties and methods on the right. Also, when you select an item on the right, you get some limited help, such as the list of a function's arguments, at the bottom of the window. Remember that such help is only a few mouse clicks away as you are doing your programming. It often provides just the detail you need to get you past a programming hurdle.

Figure 22 Visual Basic Object Browser


Microsoft Visual Basic for Applications - RISKOptimizer XDK - Multiple Optimizations.xlsm - [Object Browser]
File Edit View Insert Format Debug Run Tools Add-Ins Window Help
Project - VBAProject
Properties - Module1
Alphabetic Categorized
Search Results
Library Class Member
Immediate

```
RiskXLA (Risk.xla)
Solver (SOLVER.XLAM)
VBAProject (RISKOptimizer XDK - Mu
  Microsoft Excel Objects
    Sheet4 (Explanation)
    ThisWorkbook
    wsModel (Model)
    wsResults (Results)
  Modules
    Module1
  References
VBAProject (RiskRibbon_EN.xlam)
```

Module1 Module

(Name) Module1

Palisade_Risk_XDK8

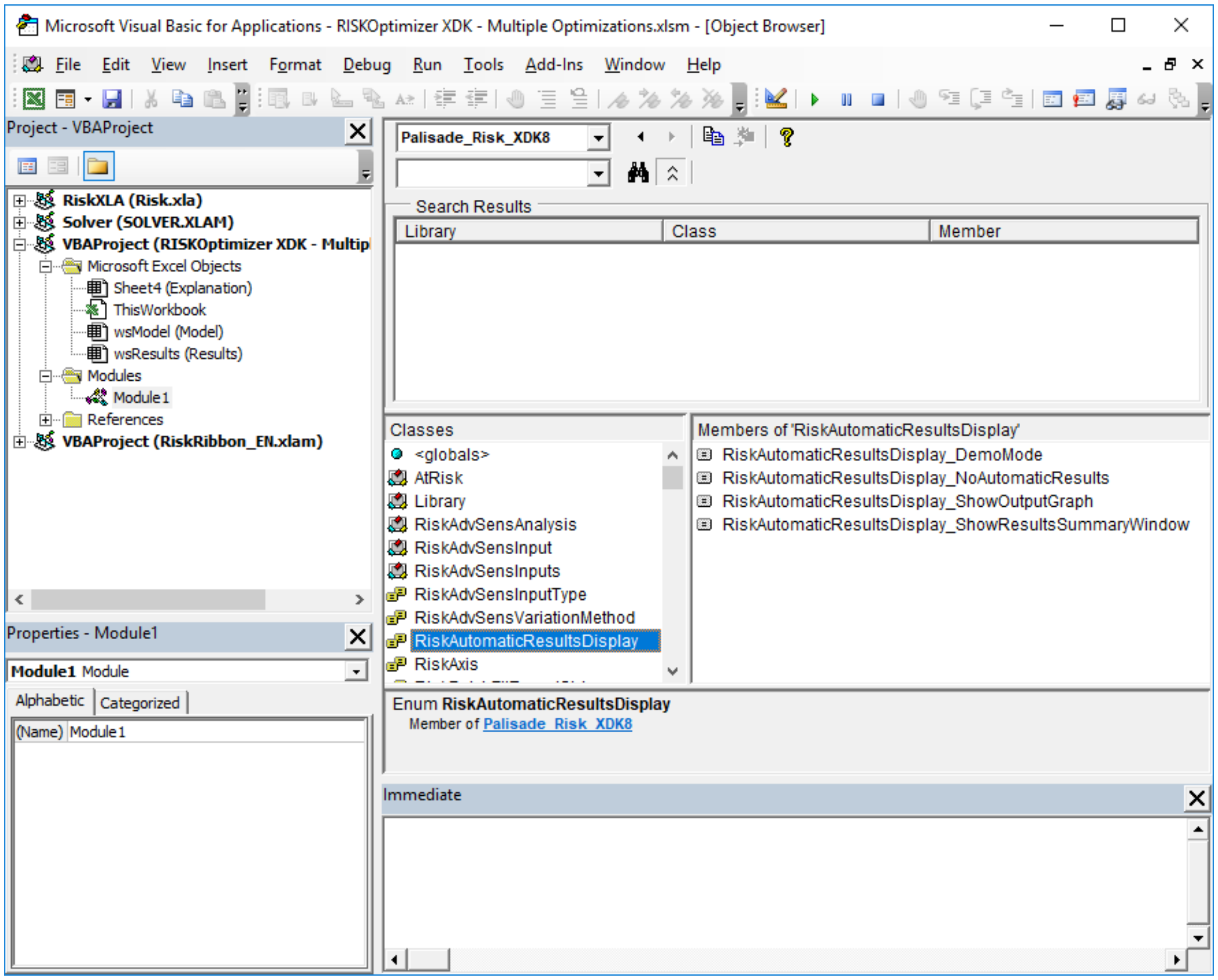
Classes	Members of 'RiskSimResults'
RiskResultsStorage	Clear
RiskSamplingType	Exist
RiskScalingFactor	Filters
RiskScenarioData	GetSimulatedInput
RiskScenarioDisplayMode	GetSimulatedOutput
RiskSensitivityData	GetType
RiskSensitivitySettings	GraphDistribution
RiskSensitivityTornadoFormat	GraphScatter
RiskSimResults	GraphScenarioTornado
RiskSimResultStatus	GraphSensitivitySpider
RiskSimulatedResult	GraphSensitivityTornado
RiskSimulation	GraphSummaryBoxPlot
RiskSimulationCompletionStatus	GraphSummaryTrend
RiskSimulationSettings	NumInputs
RiskStandardRecalcBehavior	NumOutputs
RiskStaticValueType	NumSimulations
RiskStatisticFunctionUpdating	RandomNumberGenerator

Function **GraphDistribution**(*p_ResultsToGraph*, [*p_Simulation*], [*p_SuppressTheoreticalOverlay As Boolean* = False]) As RiskGraph
Member of Palisade_Risk_XDK8.RiskSimResults

Constants and Enumerations

The line **.AutomaticResultsDisplay = RiskAutomaticResultsDisplay_NoAutomaticResults** contains one of many built-in @RISK constants, in this case, RiskAutomaticResultsDisplay_NoAutomaticResults. All of these constants begin with Risk, and they all have integer values, such as 3 or 445. However, because no person could ever remember these values, they are instead given meaningful names that programmers can use in their VBA code. You can find the names in the Object Browser. For example, Figure 23 lists the constants (on the right) for the four possible settings of the **AutomaticResultsDisplay** property. Together, this set of four constants is called an **enumeration**. (Strictly speaking, the AutomaticResultsDisplay property returns the RiskAutomaticResultsDisplay enumeration. This is only one of several enumerations available in @RISK, indicated by the double-yellow icons in the figure.[5])

Figure 23 RiskAutomaticResultsDisplay Enumeration


Microsoft Visual Basic for Applications - RISKOptimizer XDK - Multiple Optimizations.xlsm - [Object Browser]
File Edit View Insert Format Debug Run Tools Add-Ins Window Help
Project - VBAProject
RiskXLA (Risk.xla)
Solver (SOLVER.XLAM)
VBAProject (RISKOptimizer XDK - Multip
Microsoft Excel Objects
Sheet4 (Explanation)
ThisWorkbook
wsModel (Model)
wsResults (Results)
Modules
Module1
References
VBAProject (RiskRibbon_EN.xlam)
Properties - Module1
Module1 Module
Alphabetic Categorized
(Name) Module1
Palisade_Risk_XDK8
Search Results
Library Class Member
Classes
<globals>
AtRisk
Library
RiskAdvSensAnalysis
RiskAdvSensInput
RiskAdvSensInputs
RiskAdvSensInputType
RiskAdvSensVariationMethod
RiskAutomaticResultsDisplay
RiskAxis
Members of 'RiskAutomaticResultsDisplay'
RiskAutomaticResultsDisplay_DemoMode
RiskAutomaticResultsDisplay_NoAutomaticResults
RiskAutomaticResultsDisplay_ShowOutputGraph
RiskAutomaticResultsDisplay_ShowResultsSummaryWindow
Enum RiskAutomaticResultsDisplay
Member of Palisade_Risk_XDK8
Immediate

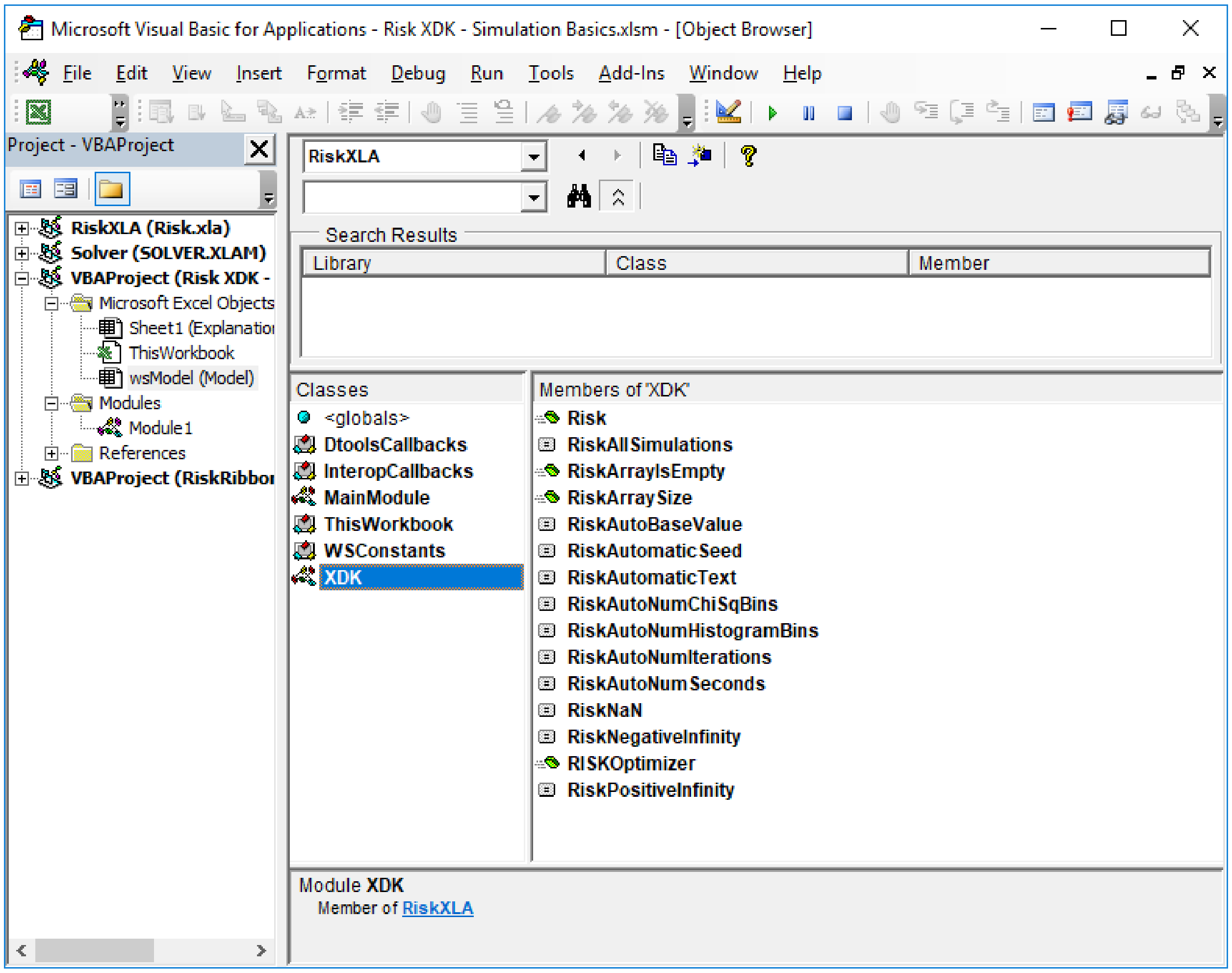
[5] Excel also has many enumerations. Its built-in constants all begin with xl, as in xlDown, xlToRight, and so on.

@Risk XDK also includes some stand-alone constants that do not belong to enumerations, for example RiskAutoNumIterations in this code:

```
    With Risk.Simulation
        ' Change some simulation settings
        With .Settings
            ' non-enumerated constant
            .NumIterations = RiskAutoNumIterations
            ' enumerated constant
            .AutomaticResultsDisplay = RiskAutomaticResultsDisplay_NoAutomaticResults
        End With
    End With
```

To find the non-enumerated constants in the Object Browser, we need to select RiskXLA as the library to view, and then click XDK in the list of classes, as shown in Figure 24.

Figure 24 @Risk XDK Non-Enumerated Constants



Members of 'XDK'

Risk
RiskAllSimulations
RiskArrayIsEmpty
RiskArraySize
RiskAutoBaseValue
RiskAutomaticSeed
RiskAutomaticText
RiskAutoNumChiSqBins
RiskAutoNumHistogramBins
RiskAutoNumIterations
RiskAutoNumSeconds
RiskNaN
RiskNegativeInfinity
RISKOptimizer
RiskPositiveInfinity

Module XDK
Member of RiskXLA

Appendix

The document to this point contains all of the information you need to get started with VBA for @RISK. This appendix contains extra information, some of which is rather technical, that might come in handy.

Updating @RISK 6.x or 7.x Automation Code to Run in @RISK 8.x

Overview

Moving to version 8, Palisade has reviewed and improved the XDK interface, taking into account new features and the needs of .NET programmers. This resulted in some changes to the Object Model, method names and parameters, and names of enumerated constants. The major changes are described here in reference to VBA code, but not every detail is covered. In some cases when code created for earlier versions does not compile in version 8, one may need to review the new interface to identify a new way of accomplishing the same objective. Usually it will be possible to identify a similarly named method or property that accomplishes the same task; or in some cases changes to code will be forced by a modified list of method parameters in version 8. However, every effort was made to not change the interface unless necessary, and over 90% of the interface is the same as in previous versions.

Updating Library References

If you have @RISK automation code written for @RISK 6.x or 7.x, you'll need to change the references as described before in this guide for that code to work with @RISK 8.x.

Changes to the Object Model

- The Risk.Simulation.Results.Reports object has been added, reflecting improved reporting functionality in version 8
- The Risk.ApplicationSettings object was replaced by the Risk.Preferences object, corresponding the new method of handling user settings in version 8. Some properties may no longer be found in the new object, while new ones have been added.
- The Risk.Library object is no longer available, corresponding to the changed form of this functionality in version 8.

New Interface for Generating the Standard Reports

Version 8 improved the reporting functionality significantly, with new report types, the option of generating reports in the PDF format, and flexibility in specifying which inputs/output to include in the reports. Consequently, the single Risk.GenerateExcelReports method in version 7 was replaced by a number of methods in the Risk.Simulation.Results.Reports object.

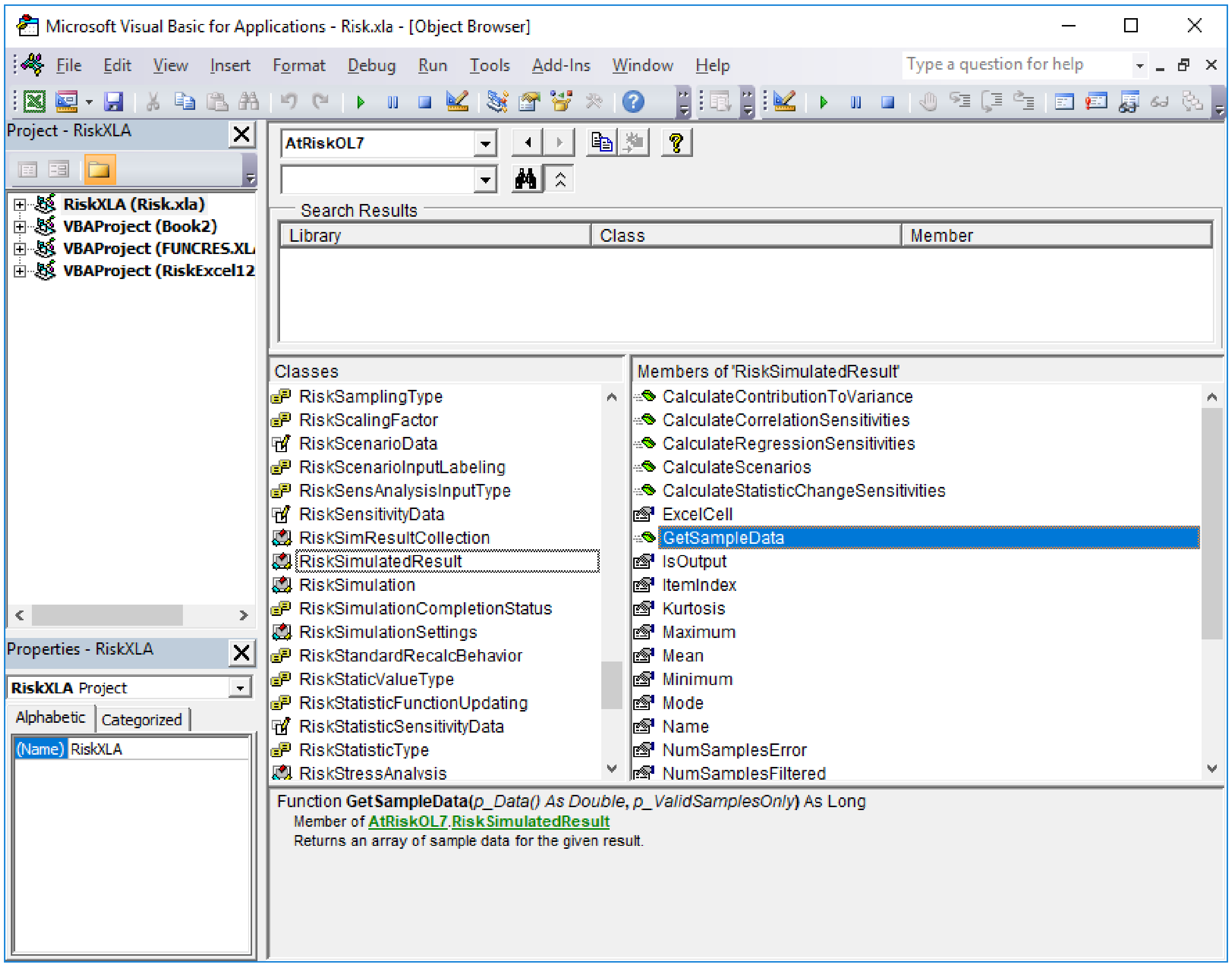
New Format of Enumerated Constant Names

There is a new format for names of enumerated constants in version 8, requiring some changes in VBA code wherever an enumerated constant was used. It should be straightforward to identify the new name of a constant, particularly that the names of the enumerations generally have not changed. For example, "RiskAutomaticResultsDisplay.RiskNoAutomaticResults" in versions 6/7 became "RiskAutomaticResultsDisplay.RiskAutomaticResultsDisplay_RiskNoAutomaticResults". In general, the names of enumerations are included as prefixes in the names of the constants.

New Method of Returning Arrays

In version 8 arrays are returned differently to client code. For example, in version 7 to obtain all the values an output had during a simulation, one called the GetSampleData method, with the array of values returned in the first parameter, as shown in the Figure 25. The return value from the method is the length of the array.

Figure 25 Method of Returning Arrays in Version 7



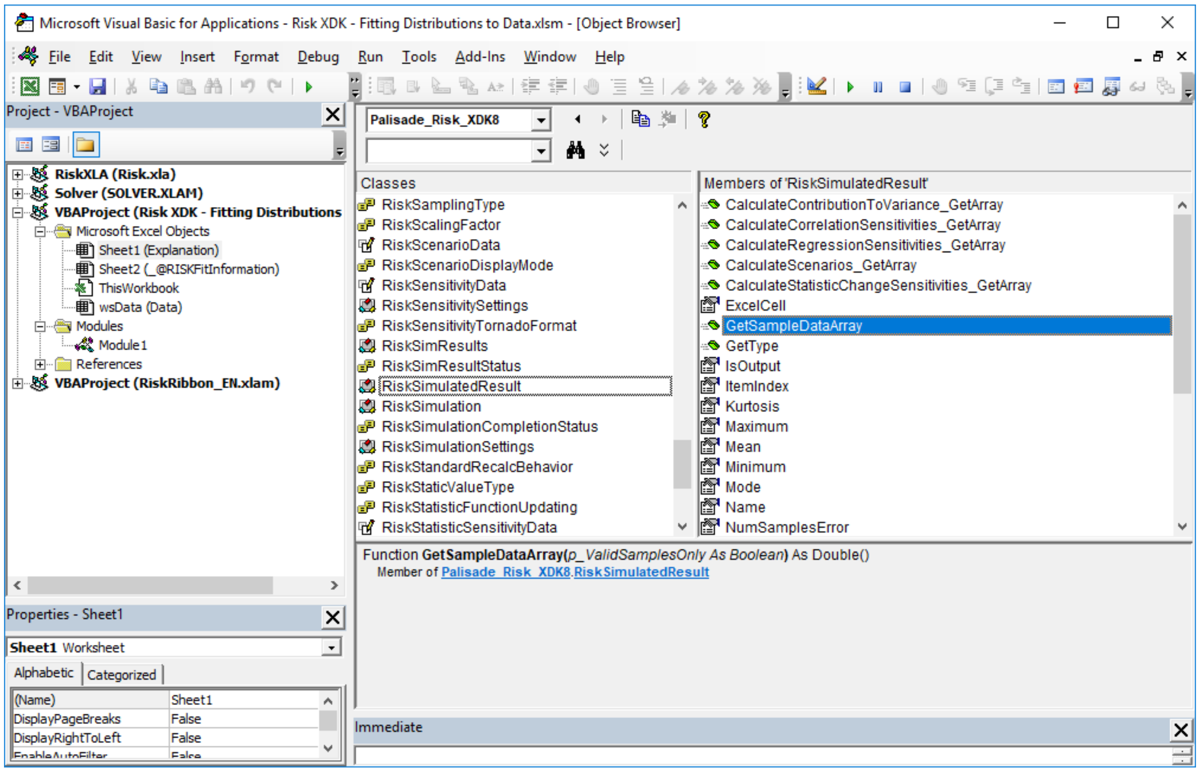
Classes
RiskSamplingType
RiskScalingFactor
RiskScenarioData
RiskScenarioInputLabeling
RiskSensAnalysisInputType
RiskSensitivityData
RiskSimResultCollection
RiskSimulatedResult
RiskSimulation
RiskSimulationCompletionStatus
RiskSimulationSettings
RiskStandardRecalcBehavior
RiskStaticValueType
RiskStatisticFunctionUpdating
RiskStatisticSensitivityData
RiskStatisticType
RiskStressAnalysis

Members of 'RiskSimulatedResult'
CalculateContributionToVariance
CalculateCorrelationSensitivities
CalculateRegressionSensitivities
CalculateScenarios
CalculateStatisticChangeSensitivities
ExcelCell
GetSampleData
IsOutput
ItemIndex
Kurtosis
Maximum
Mean
Minimum
Mode
Name
NumSamplesError
NumSamplesFiltered

Function **GetSampleData**(*p_Data() As Double*, *p_ValidSamplesOnly*) As Long
Member of AtRiskOL7.RiskSimulatedResult
Returns an array of sample data for the given result.

Figure 26 shows the corresponding method in version 8. The name was changed to GetSampleDataArray, to underscore the change to method parameters. The array is no longer returned inside a parameter; it is now the return value from the function. The length of the array is not returned. In general, the length of an array can be determined using VBA functionality. However, there is a possibility of introducing bugs if one does not account properly for empty arrays. For this reason, the XDK includes two utility methods for checking the size of an array, RiskArrayIsEmpty and RiskArraySize, as seen in Figure 27.

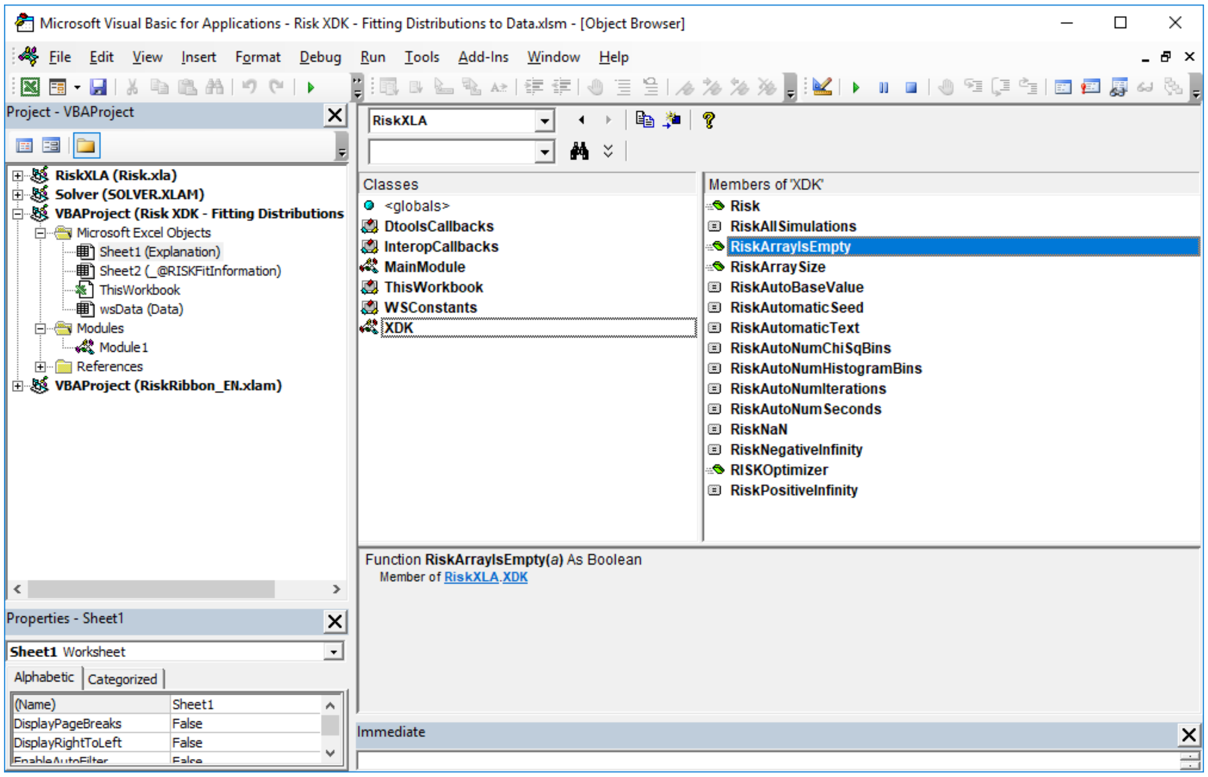
Figure 26 Method of Returning Arrays in Version 8


Microsoft Visual Basic for Applications - Risk XDK - Fitting Distributions to Data.xlsm - [Object Browser]
File Edit View Insert Format Debug Run Tools Add-Ins Window Help
Project - VBAProject
RiskXLA (Risk.xla)
Solver (SOLVER.XLAM)
VBAProject (Risk XDK - Fitting Distributions
Microsoft Excel Objects
Sheet1 (Explanation)
Sheet2 (_@RISKFitInformation)
ThisWorkbook
wsData (Data)
Modules
Module1
References
VBAProject (RiskRibbon_EN.xlam)
Properties - Sheet1
Sheet1 Worksheet
Alphabetic
Categorized
Palisade_Risk_XDK8
Classes
RiskSamplingType
RiskScalingFactor
RiskScenarioData
RiskScenarioDisplayMode
RiskSensitivityData
RiskSensitivitySettings
RiskSensitivityTornadoFormat
RiskSimResults
RiskSimResultStatus
RiskSimulatedResult
RiskSimulation
RiskSimulationCompletionStatus
RiskSimulationSettings
RiskStandardRecalcBehavior
RiskStaticValueType
RiskStatisticFunctionUpdating
RiskStatisticSensitivityData
Members of 'RiskSimulatedResult'
CalculateContributionToVariance_GetArray
CalculateCorrelationSensitivities_GetArray
CalculateRegressionSensitivities_GetArray
CalculateScenarios_GetArray
CalculateStatisticChangeSensitivities_GetArray
ExcelCell
GetSampleDataArray
GetType
IsOutput
ItemIndex
Kurtosis
Maximum
Mean
Minimum
Mode
Name
NumSamplesError
Immediate

(Name)	Sheet1
DisplayPageBreaks	False
DisplayRightToLeft	False
EnableAutoFilter	False

Function **GetSampleDataArray(***p_ValidSamplesOnly As Boolean***)** As Double()
Member of Palisade_Risk_XDK8.RiskSimulatedResult

Figure 27 XDK Utility Methods for Checking Sizes of Returned Arrays


Microsoft Visual Basic for Applications - Risk XDK - Fitting Distributions to Data.xlsm - [Object Browser]
File Edit View Insert Format Debug Run Tools Add-Ins Window Help
Project - VBAProject
Properties - Sheet1
Immediate
RiskXLA

RiskXLA (Risk.xla)
Solver (SOLVER.XLAM)
VBAProject (Risk XDK - Fitting Distributions
Microsoft Excel Objects
Sheet1 (Explanation)
Sheet2 (_@RISKFitInformation)
ThisWorkbook
wsData (Data)
Modules
Module1
References
VBAProject (RiskRibbon_EN.xlam)

Sheet1 Worksheet

Alphabetic | Categorized

(Name)	Sheet1
DisplayPageBreaks	False
DisplayRightToLeft	False
EnableAutoFilter	False

Classes
<globals>
DtoolsCallbacks
InteropCallbacks
MainModule
ThisWorkbook
WSConstants
XDK

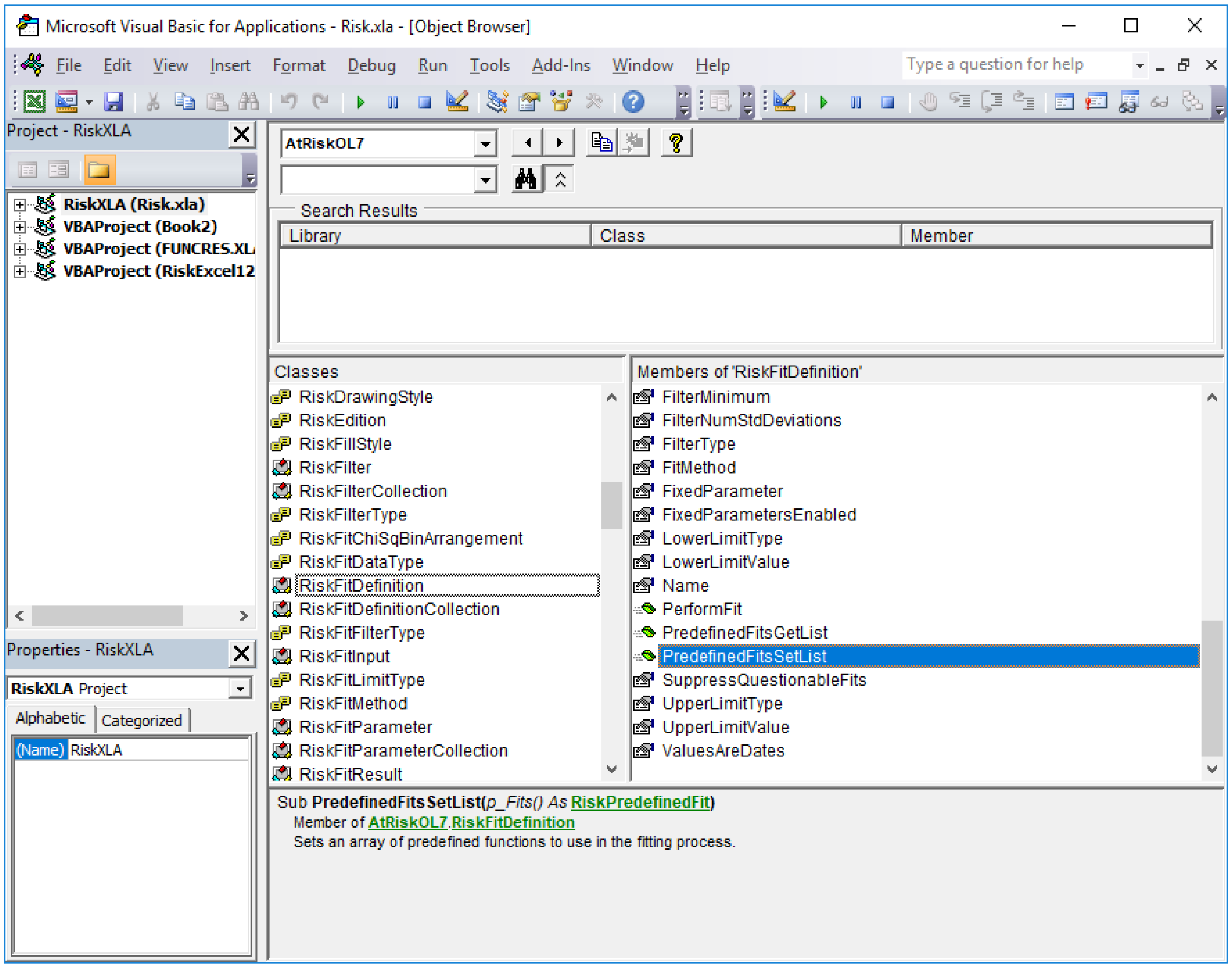
Members of 'XDK'
Risk
RiskAllSimulations
RiskArrayIsEmpty
RiskArraySize
RiskAutoBaseValue
RiskAutomaticSeed
RiskAutomaticText
RiskAutoNumChiSqBins
RiskAutoNumHistogramBins
RiskAutoNumIterations
RiskAutoNumSeconds
RiskNaN
RiskNegativeInfinity
RISKOptimizer
RiskPositiveInfinity

Function **RiskArrayIsEmpty**(*a*) As Boolean
Member of RiskXLA.XDK

New Method of Passing Arrays to the XDK

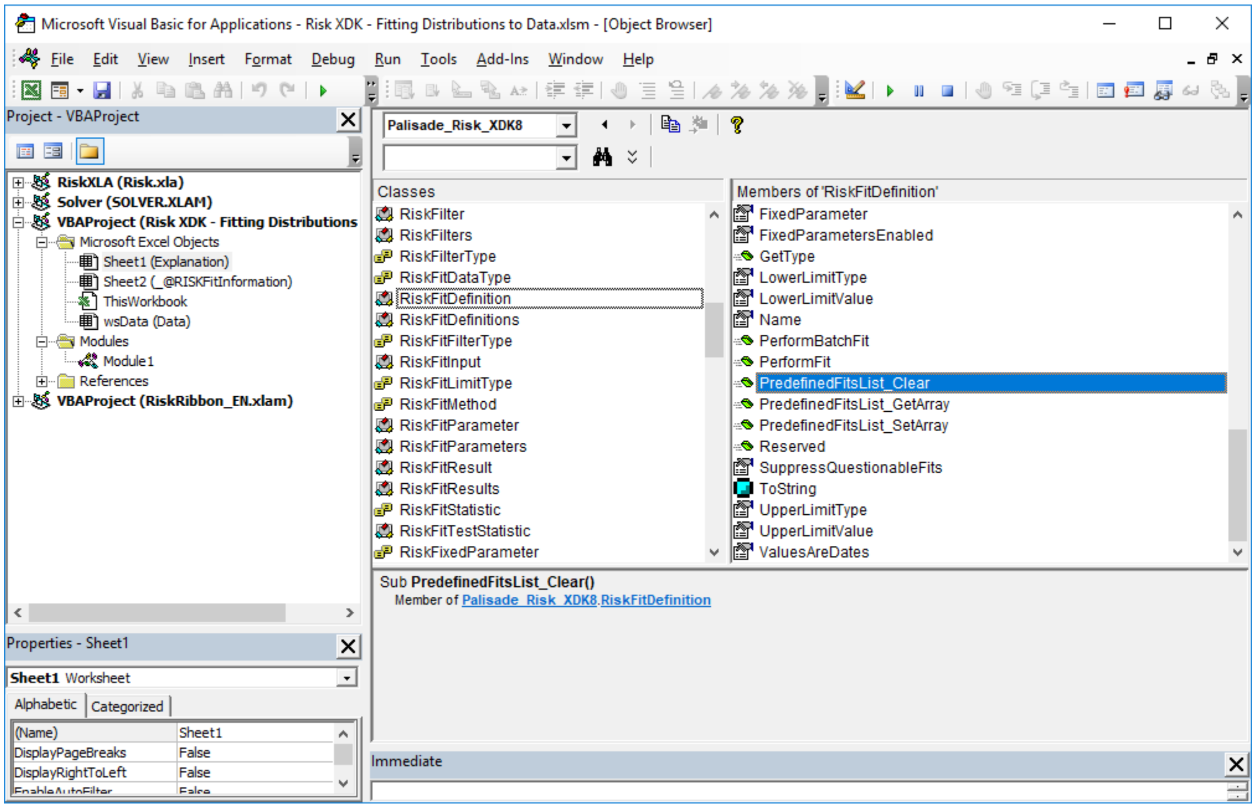
In a few instances in the XDK interface an array is passed by the client code to the XDK. For example, Figure 28 shows the PredefinedFitsSetList method in version 7 (used to pass a list of theoretical probability distributions to fit to data). In version 8 (Figure 29) this method has been separated into two methods, PredefinedFitList_SetArray and PredefinedFitList_Clear. The second method should be used to clear the array stored by the XDK; as opposed to passing an empty array. **Important: passing empty arrays to the XDK _SetArray methods can result in Excel crashes**. This is due to a bug involving the interaction between VBA and .NET when handling arrays, and is beyond Palisade's control.

Figure 28 Passing Arrays to XDK in Versions Prior to 8



Sub **PredefinedFitsSetList**(*p_Fits() As* RiskPredefinedFit)
Member of AtRiskOL7.RiskFitDefinition
Sets an array of predefined functions to use in the fitting process.

Figure 29 Passing Arrays to XDK in Versions 8



(Name)	Sheet1
DisplayPageBreaks	False
DisplayRightToLeft	False
EnableAutoFilter	False

Sub **PredefinedFitsList_Clear()**
Member of Palisade_Risk_XDK8.RiskFitDefinition

Changes to Methods for Graphing Results

The interface of methods for graphing sensitivity results has changed. Those methods had long lists of arguments. Now there is a new RiskSensitivitySettings object. A programmer can create one of those objects, specify some properties like GraphMaxTornadoBars, and pass the object as a parameter to the graphing method:

- The GraphTornado and GraphTornadoEx methods have been merged into a single GraphSensitivityTornado method (which takes a RiskSensitivitySettings object as an optional parameter).
- The GraphSpider method has been renamed as GraphSensitivitySpider, and it also takes a RiskSensitivitySettings object as an optional parameter.

Also, the GraphSummary method was replaced by two methods, GraphSummaryBoxPlot and GraphSummaryTrend.

Risk.RefreshUI Method Added

This method was added to address the fact that some XDK calls should update the Excel interface, for example by making changes to the items displayed in the @RISK tab in the ribbon. For instance, setting Risk.Simulation.Settings.NumIterations should update the number of iterations shown on the ribbon.

However, refreshing the interface is time consuming, and setting individual properties no longer refreshes the interface, to avoid multiple unnecessary and time-consuming updates. The RefreshUI method should be called to update the ribbon when needed.

Item no Longer the Default Property

The Item property of collection classes is no longer the default property. So, for example a line deleting a definition of a fit, "Risk.Fits("Costs").Delete" in version 7, becomes "Risk.Fits.Item("Costs").Delete in version 8.

Different Initialization Method with the .NET Interface

See the section of this guide that covers the .NET interface.

Updating RISKOptimizer 6.x or 7.x Automation Code to Run in @RISK 8.x

If you have RISKOptimizer automation code written for @RISK 6.x or 7.x, that code will continue to work with @RISK 8.x provided that you change the references as described above.

Demand-Loading @RISK

Usually, you want @RISK to load automatically when you open the file that contains the VBA for @RISK code. By adding the reference to RiskXLA in the VBA references as described earlier, this will occur. However, there are some instances where this is not the behavior you want. For example, you might want to write an add-in that uses @RISK only part of the time, in which case requiring @RISK to always be loaded is not appropriate. The programmer of an add-in that uses @RISK XDK, but has no reference to RiskXLA, needs to arrange for @RISK to be loaded before the calls to @RISK XDK are made. This could be done by displaying a message asking a user to launch @RISK, before they are allowed to access some functionality of the custom add-in that depends on the programmatic interface of @RISK.

If you remove the RiskXLA reference, you can still automate @RISK, but you need to do some extra work to obtain the root Risk reference object and to use any @RISK constants defined in that file. You can get the root Risk object in a "late-bound" fashion—that is without an early-bound reference to RiskXLA—by using Excel's Application.Run command as follows:

```
Dim Risk As Palisade_Risk_XDK8.AtRisk
Set Risk = Application.Run(“Risk.xla!Risk”)
```

This code assumes @RISK is already loaded and calls the public property Risk in a late-bound fashion to retrieve the root automation object. If you store Risk as a global (non-local) variable, it is a good practice to set it to Nothing when you are finished using @RISK for automation. (Strictly speaking, you could call this variable anything, but by using the variable name "Risk," your code will be only minimally changed.)

Another purpose that the early-bound reference to Risk.xla serves is to provide all the automation constants (RiskAutoNumIterations, RiskNaN, and so on) that you might need for your code. For example, consider the following line of code:

```
Risk.Simulations.Settings.NumIterations = RiskAutoNumIterations
```

Here, the constant RiskAutoNumIterations is provided by the reference to RiskXLA. If you choose to demand load @RISK, however, and thus do not have a reference to RiskXLA, these constants won't be available directly. Instead, you will need to access them from the Risk.Constants object, as demonstrated below:

```
Risk.Simulations.Settings.NumIterations = Risk.Constants.RiskAutoNumIterations
```

The RISKOptimizer root object can also be accessed in the late-bound manner, as follows:

```
Dim RISKOptimizer As RISKOptOL8.RISKOptimizerRoot
Set RISKOptimizer = Application.Run("Risk.xla!RISKOptimizer")
```

Automating @RISK from .NET

Although the @RISK automation library is designed primarily for use from within Excel's VBA language (and all the code examples of this documentation, except for this section, are written for VBA), it is also possible to use the .NET environment to control @RISK. Note the custom .NET code must run inside the Excel process, after @RISK has been launched.

To automate @RISK from .NET, you must first add a reference to the Visual Studio project. Specifically, you should browse to the "Program Files (x86)\Palisade\System" folder (or "Program Files\Palisade\System" on 32-bit versions of Windows) and add a reference to the Palisade.Risk.XDK8.dll assembly. The developers of custom applications need not concern themselves with the availability of this or other Palisade assemblies at runtime; they will be loaded when @RISK is launched in Excel.

It may also be necessary to add a reference to the Excel automation library. Some methods in the XDK return objects from the Excel automation interface, or take such objects as parameters; examples of such objects are a Workbook or a Range. If those methods are used, then a "Microsoft Excel x.0 Object Library" reference has to be added to the project from the COM tab of the Reference Manager dialog.

In the .NET interface all the functionality is available via methods of the Risk class in the Palisade.Risk.XDK8.dll assembly; those methods will show as static to C# code as as shared to VB .NET code. There is a required initialization call in the .NET interface, to be made before any other calls to the XDK (unlike in the VBA interface). Assuming the Palisade.Risk.XDK namespace has been declared with the "using" (C#) or the "Imports" (VB .NET) keywords, the call to make is:

C# Code

```
    Risk.Initialize();
```

VB .NET Code

```
    Risk.Initialize()
```

Programmers who need to convert existing .NET code that was written for version 7 of @RISK should note some differences in the initialization process. In that version a root "Risk" object had to be obtained using an Excel automation call (Application.Run); this code should be removed when converting XDK code from version 7 to version 8. Also, the Initialize call needs to be added, as it was not required in version 7.

The object model for the .NET interface is the same as the one for the VBA interface. Generally, the documentation for the VBA interface should be sufficient when writing .NET code. Here is some sample .NET code which changes the number of iterations to automatic and runs a simulation.

C# Code

```
//This code assumes "using Palisade.Risk.XDK;" line has been added, and the initialization call
// has been made.
public void RunSimulation()
{ Risk Risk;
    Risk.Simulation.Settings.NumIterations = Risk.RiskAutoNumIterations;
    Risk.RefreshUI(); // make sure the ribbon actually shows "Auto" for # of iterations
    Risk.Simulation.Start();
}
```

VB .NET Code

```
'This code assumes that "Imports Palisade.Risk.XDK" line has been added, and the initialization
'call has been made.
Public Sub RunSimulation()
    Risk.Simulation.Settings.NumIterations = Risk.RiskAutoNumIterations
    Risk.RefreshUI() ' make sure the ribbon actually shows "Auto" for # of iterations
    Risk.Simulation.Start()
End Sub
```

Automating RISKOptimizer from .NET

It is also possible automate RISKOptimizer from .NET. In this case, additional references should be added to the project from the COM tab of the Reference Manager dialog:
"Microsoft Excel x.0 Object Library", and
“Palisade RISKOptimizer 8.x for Excel Developer Kit".

In addition, the RISKOptimizer root object needs to be accessed in a late-bound manner by making an automation call to Excel, as shown in the following examples. This code changes the number of trials to run to 500, and starts an optimization.

C# Code

```
// This code assumes "using RISKOptOL8;" line has been added.
public void RunOptimization(Microsoft.Office.Interop.Excel.Application.Application ExcelApp)
    {
         RISKOptimizerRoot RISKOpt;
         RISKOpt = (RISKOptimizerRoot)ExcelApp.Run("Risk.xla!RISKOptimizer");
         OptModelWorkbook mwb = RISKOpt.ModelWorkbook(ExcelApp.ActiveWorkbook, false);
         mwb.OptimizationSettings.Runtime.TrialCountStoppingCondition = true;
         mwb.OptimizationSettings.Runtime.TrialCount = 100;
         RISKOpt.Optimize();
     }
```

VB .NET Code

```
' This code assumes that "Imports Microsoft.Office.Interop" as well as "Imports RISKOptOL8"
' lines have been added
Public Sub RunOptimization(ByVal ExcelApplication As Excel.Application)
    Dim RISKOptimizer As RISKOptimizerRoot
    RISKOptimizer = ExcelApplication.Run("Risk.xla!RISKOptimizer")
    RISKOptimizer.ModelWorkbook.OptimizationSettings.Runtime.TrialCountStoppingCondition = True
    RISKOptimizer.ModelWorkbook.OptimizationSettings.Runtime.trialCount = 500
    RISKOptimizer.Optimize()
End Sub
```