

# Delivering Just-In-Time Learning with Self-Correcting Excel Worksheets

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Excel is the tool of choice in the business world for data analysis and financial modeling. In higher education Excel can be used to provide students with a hands on just-in-time learning experience. By using conditional formatting, dynamic graphs, embedded comments, and other Excel features faculty can create rich interactive worksheets that provide students real-time feedback. This paper describes the basic techniques for creating self-correcting worksheets to illustrate a variety of financial concepts ranging from simple time value of money problems to complex financial analysis and simple Monte Carlo simulations. It also provides examples of how to use dynamic graphs, embedded comment, and other simple features to create rich visual hands on learning tools.

## INTRODUCTION

Excel is the tool of choice in the business world for data analysis and financial modeling, and employers increasingly expect business students to have a working knowledge of Excel and an ability to perform financial modeling. Most corporate finance texts include Excel problems in their end of chapter problems. In addition, a variety of financial modeling books are available in the marketplace. These range from stand alone texts that introduce students to sophisticated modeling products such as Crystal Ball to workbooks linked to popular introductory corporate finance texts.<sup>1</sup> Other texts, such as Brigham and Daves, Intermediate Financial Management, make use of chapter “Tool Kits” and “Build a Models” to walk students through financial concepts and provide hands on learning with Excel. This paper describes the simple steps involved in creating self-correcting Excel worksheets, which can provide a rich opportunity for a just-in-time learning experience, as well as simplify grading.

While most popular corporate finance texts include Excel worksheets keyed to selected end of chapter problems, they are often limited in terms of types of questions, their ease of use, and the feedback they provide to students. The use of self-correcting worksheets provides the structure and immediate feedback necessary to engage students in active learning outside the classroom, and can simplify faculty grading.<sup>2</sup> Combing well annotated self-correcting Excel worksheets with a “Tablet PC” creates a powerful distance learning tool.<sup>3</sup>

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<sup>1</sup> Evans, James, and Olsen, David, Introduction to Simulation and Risk Analysis, Pearson Prentice Hall, 2005, and Holden, Craig, Excel Modeling: In the Fundamentals of Corporate Finance, Pearson Prentice Hall, 2005.

<sup>2</sup> Deacon (2004) discusses the use of formative assessment techniques to engage students and promote deep learning, and notes the importance of short feedback cycles.

<sup>3</sup> Hall (2003) identifies potential benefits of laptop technology into the classroom. These include instantaneous feedback, access to real-time information, collaborative learning, and common educational/workforce platform for problem solving. The combination of self-correcting Excel worksheets and a “Tablet PC” to create a powerful distance learning tool is discussed in a subsequent section.

## BUILDING MODELS

Conditional formatting is the key to building self-correcting Excel worksheets. Conditional formatting can be used to change a cell's shading or font if the cell meets a user defined condition. In business, conditional formatting is often used to analyze trends, identify variances, or highlight data that meets certain conditions. In an academic setting conditional formatting can be used to provide students with immediate feedback by changing cell shading or font color if answers are correct. Conditional formatting also makes it easy for faculty to quickly scan for incorrect answers and grade assignments. Authoring a basic self-correcting worksheet involves eight simple steps (Exhibit A):

1. Build an "initial" worksheet model.
2. Skip several columns or rows, and make copy of the "initial" completed model on the same worksheet tab. This copy will serve as the "worksheet's solution".
3. Select (highlight) the cells containing the initial model and apply conditional formatting to these cells.
4. Hide the columns or rows containing the "worksheet's solution".
5. On the "initial" model, unprotect the worksheet cells that you intend for the students to use for their answers ("answer cells").
6. Protect the Excel worksheet.
7. Delete the answers from the "answer cells".
8. Save your self-correcting worksheet.

Additionally, creating effective a worksheet requires the adoption of arbitrary, but standard formatting conventions, such as shading cells blue for provided information, and light yellow for student input or answer fields. Furthermore, the use of drop down menus, data validation "input messages", and/or annotated comments can improve the functionality of worksheets, and provide students with important instructional information for just-in-time learning.

### *Conditional Formatting*

Conditional formatting may be used on cells with either numeric or text inputs. Conditions can take the form of a combination of inequalities ( $>$ ,  $<$ ,  $\neq$ ,  $\geq$ ,  $\leq$ ), or an equality.<sup>4</sup> Conditions can be based on specified values or by making a reference to the value of another cell. Making use of relative cell references makes the extension of conditional formatting through out a worksheet an easy proposition. Conditional formatting can be copied using the format painter or copy command. For text inputs the use of drop down menus is important, as equality conditions are case sensitive and require an exact spelling match.

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<sup>4</sup> If students use Excel formulas for cell calculations rounding is rarely an issue. However, rounding can be an issue, if a problem requires the use of estimates, or if a students use an electronic calculator for intermediate calculations. Fortunately, the issue of rounding is easily addressed though the use of the "between" condition. For example, the condition (between .99X and 1.01X) specifies a range of acceptable solutions.

### *Drop Down Menus*

Drop down menus are an effective means of ensuring the exact match required when applying conditional formatting to text fields. Drop down menus are created with Excel's data validation feature, which is accessed by selecting "Data" from Excel's main menu, followed by "Validation". On the "Settings" tab a list of potential cell inputs is created. The validation criterion is a "List" and the "Source" can take one of two forms. The "Source" data can be specified with commas separating each input choice, or the "Source" data can make reference to a range of worksheet cells that include the desired input choices (Exhibit B).

### *Input Messages*

Another important use of Excel's data validation feature is to provide students with guidance concerning the type of data input that is expected. The "Input Message" tab presents users with a specific message when they click on a cell. The message may instruct the student that the cell requires the use an Excel formula, that the required input is data provided in the question/problem, that the answer should be selected from a drop down menu, or it may offer students just-in-time instructions on how to perform a calculation (for example a financial ratio). Input message fields are limited to 300 characters, they can't be formatted, and require users to click on the cell to reveal its contents. Another option for providing students with guidance or instruction is to make use of Excel's comment feature.

### *Worksheet Comments*

Excel's comment feature is an excellent tool for providing students with real time guidance on how to solve a problem, or provide additional insights and instruction linked to a particular task. Primary advantages of comment fields are that they may be formatted, and made directly visible to users. Comment fields may also be hidden, in which case their presence is revealed by a small red triangle.

### *Embedded Screen Shots*

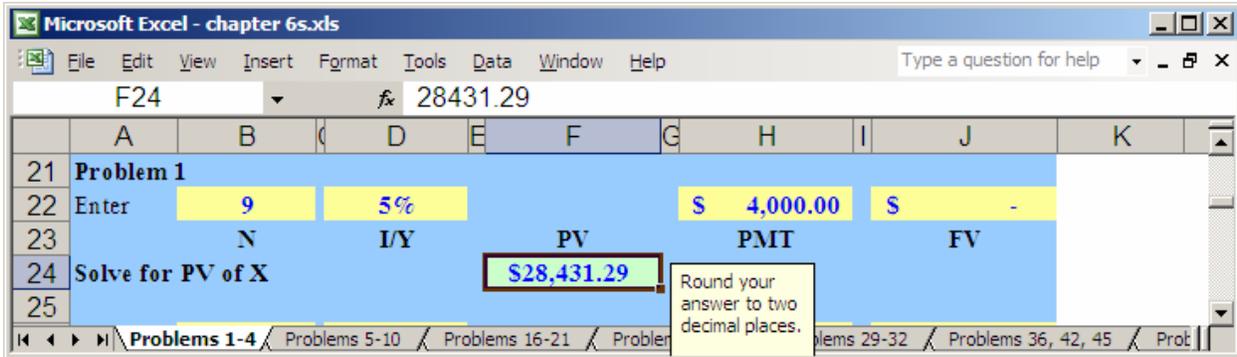
A final way to provide students with just-in-time guidance or instruction is through the use of embedded screen shots. This is particularly helpful when explaining how to use worksheet features, and students need step by step guidance on navigating menus and making entries to function input filed. To capture a screen shot of an active window hold down the [Ctrl] and [Alt] keys and press [PrtScrn]. The saved image can be pasted directly on to a worksheet tab.

## **SELF-CORRECTING WORKSHEET APPLICATIONS**

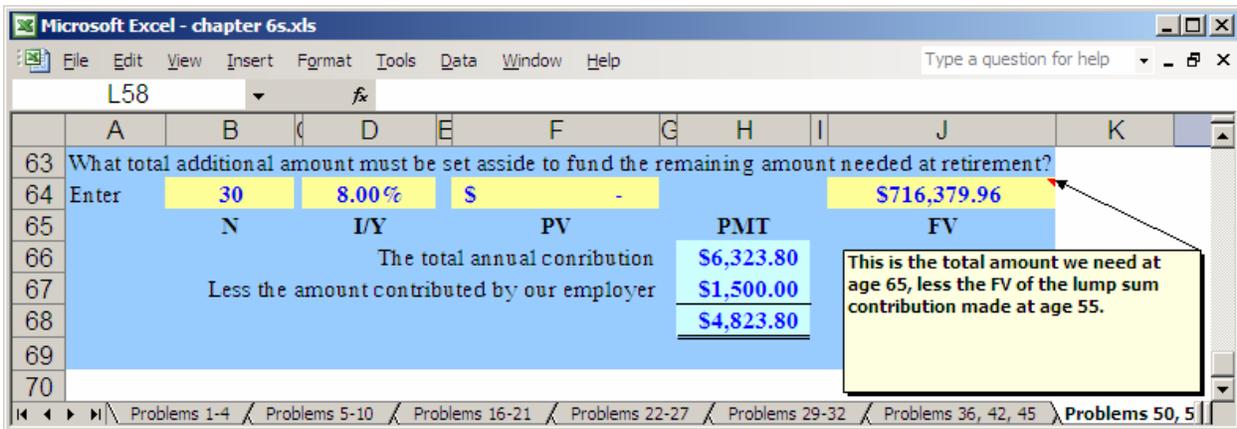
There are countless application for self-correcting worksheets, ranging from teaching students how to use their financial calculators to complex Monte Carlo simulations. This section highlights several applications.

## Teaching students how to use a financial calculator

A common challenge faced by many business students is mastering the use of their financial calculator. While Excel has built in functions for solving time value of money problems, creating worksheets to assist students with their calculators is an easy task. It simply requires creating input cells for each of the five calculator inputs. Students can check their final answer (cell F24), and/or optionally each of the individual input keys. This can be particularly helpful for problems involving compound interest, which require students to modify the interest rate and/or compounding periods.



The comment feature can be used to offer additional explanations or guidance.



When students are expected to enter values for verification, rather than use Excel formulas to perform calculations, the use of the “between” conditional format avoids errors due to rounding differences.

## Financial Statement Analysis

Financial statement analysis is another application for self-correcting Excel worksheets. Students can gain hands on experience building models to calculate financial ratios, prepare common size financial statements, and perform trend analysis. Comment fields provide just-in-time instruction and conditional formatting verifies student answers.

	1988	1989	1990	Industry
<b>Leverage and liquidity ratios :</b>				
Total liabilities to asset (%)	66.4%	36.9%	43.4%	29%
Total liabilities to equity (%)	197.2%	58.5%	76.8%	40%
Times interest earned (x)	10.10	8.46	3.77	19.16
Current ratio (x)				
Acid test (x)				
Cash Flow Liquidity* (x)				
Cash Flow Margin (%)				

**Times interest earned compares earnings before interest and taxes (EBIT or Operating Profit) with interest expense. The higher the ratio the easier it is for a firm to meet its interest obligation.**

**TIE = EBIT / Interest Expense**

Incorporating “drop down menus” into the workbook can extend the assignment beyond basic calculations. Students can evaluate ratio trends, their overall impact, and make industry comparisons. As an added twist, “if statements” can be used to evaluate incorrect answers (as indicated by a black font) and provide corrective guidance.

	Trend	Evaluation	Contribution	Industry Comparison
<b>3) Total Asset Turnover (TAT)</b>				
Total Asset Turnover	Increase	Better	n/a	Better
A/R turnover	Increase	Better	Offsets	Worse
Inventory turnover	Increase	Better	Offsets	Worse
Fixed asset turnover	Decrease	Worse	Contributes	Better
A/R period in days *	Decrease	Better	Contributes	Worse
Inventory period in days *	Decrease	Better	Contributes	Worse
Days sales in cash	Decrease	Better	Contributes	Worse

**Use an “if statement” to provide corrective guidance.**

An increasing turnover is the same as the trend in total asset turnover, therefore it contributes to the overall trend.

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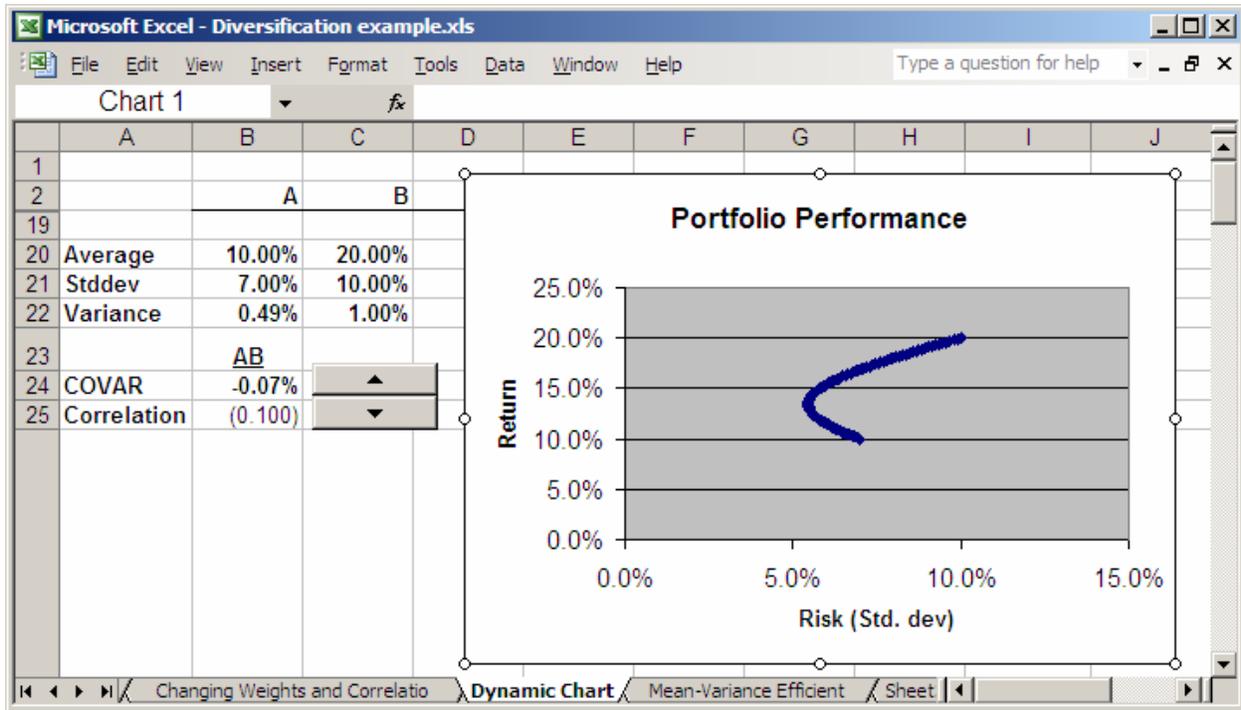
A decreasing turnover is the opposite as the trend in total asset turnover, therefore it offsets the overall trend.

Liquidity Concerns?   

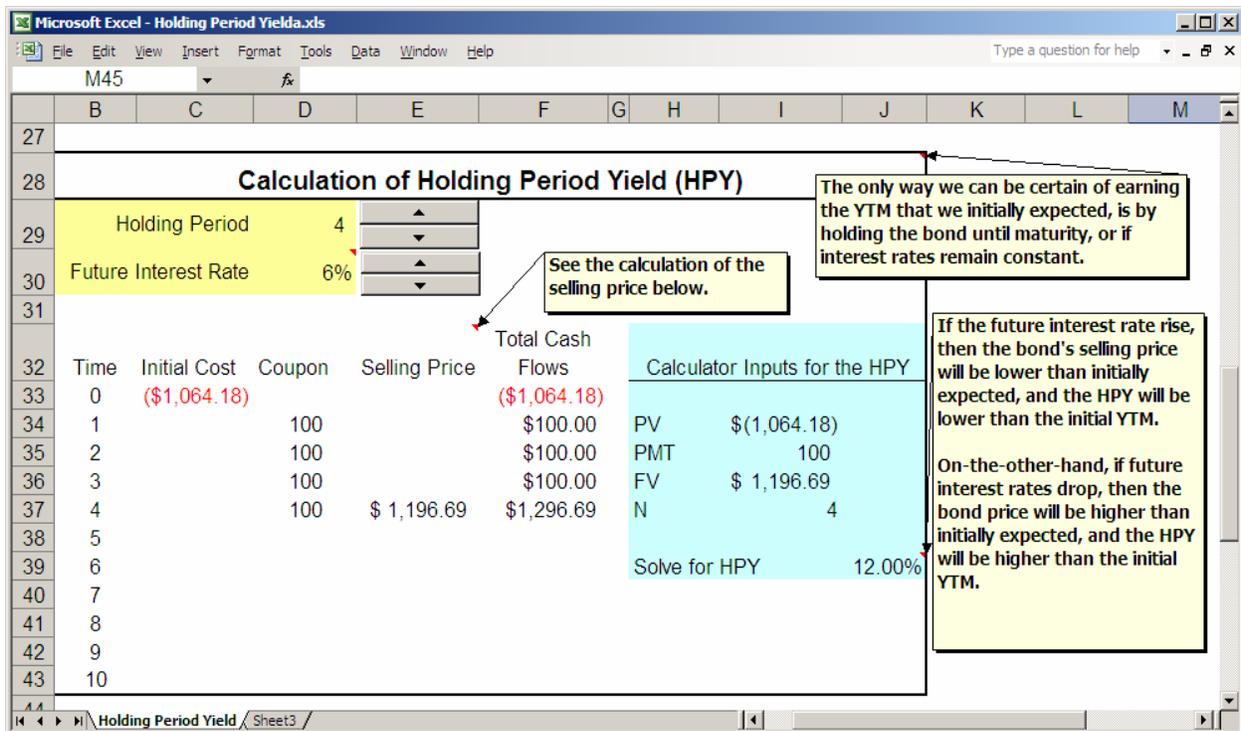
**Drop down menu**

### Spinners

Spinners are another useful Excel feature. They allow spreadsheet user to easily change input values, and observe the impact on a model or graph. Spinners are created using the “forms” “toolbar”, which is accessed from Excel’s main menu by clicking “View”. Spinners are scalable and can be inserted anywhere on a worksheet. By right-clicking on a spinner, users can format the spinner, including linking the spinner to a specific input cell. In the following example, a spinner is used to illustrate the impact of changing asset correlations on a two stock portfolio’s risk-return profile.

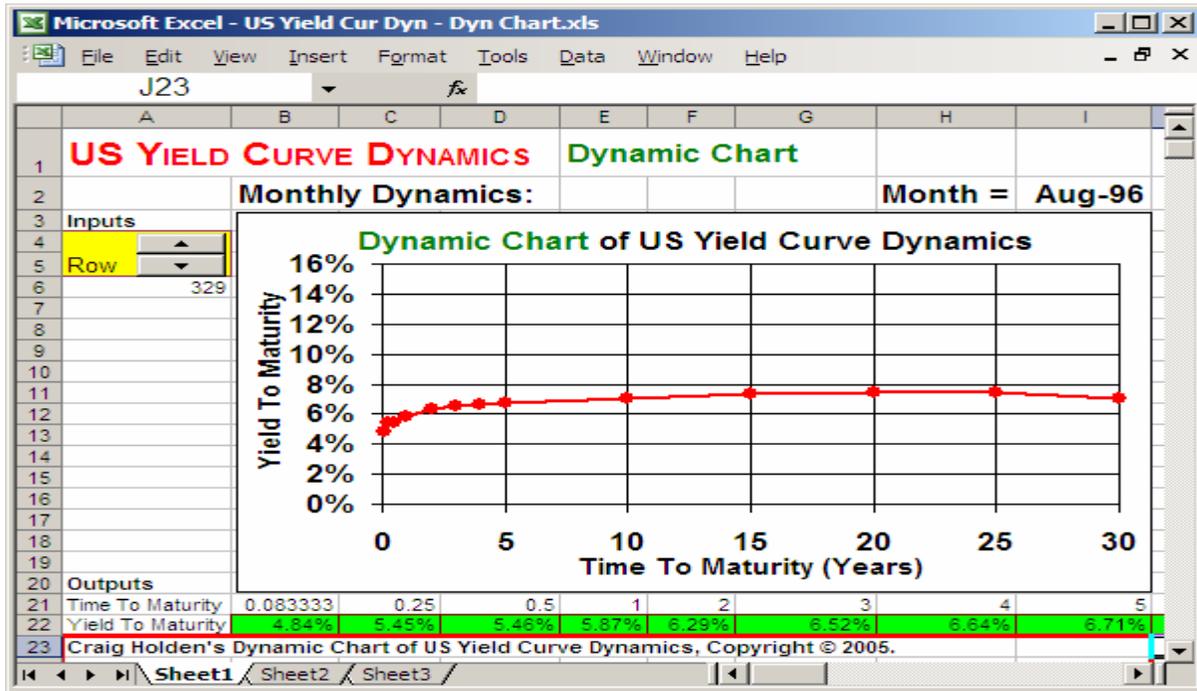


A second example involves using spinners to illustrate the impact of changing interest rates and holding periods on an investor's holding period yield. The use of embedded comments delivers timely instructional insights.



## Dynamic Charts

Craig Holden of Indiana University combined spinners with Excel's data lookup functions to create "Dynamic Charts". One such chart is a "dynamic yield curve", in which spinners are used to control a horizontal lookup function. The lookup function links monthly Treasury data to an Excel chart. The result is a "movie" like yield curve.<sup>5</sup>



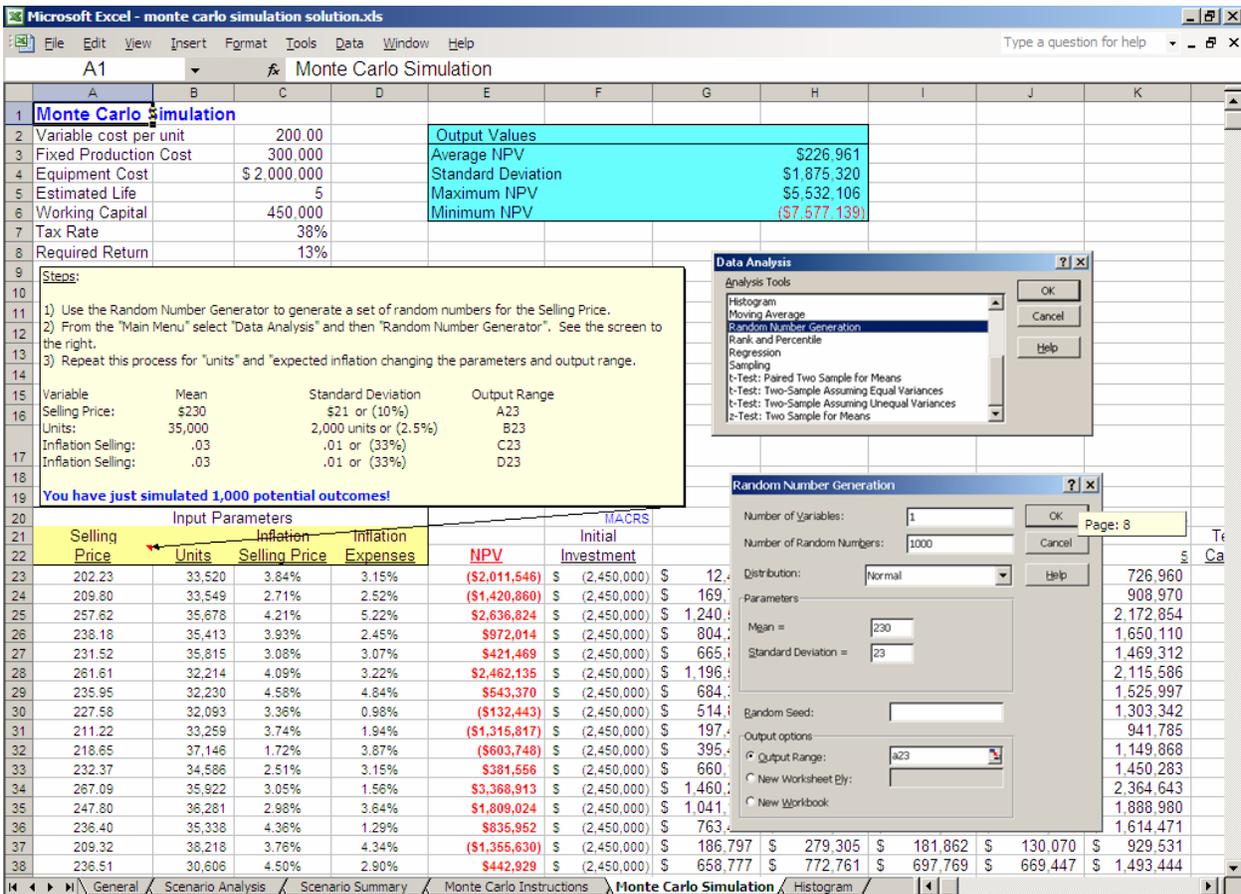
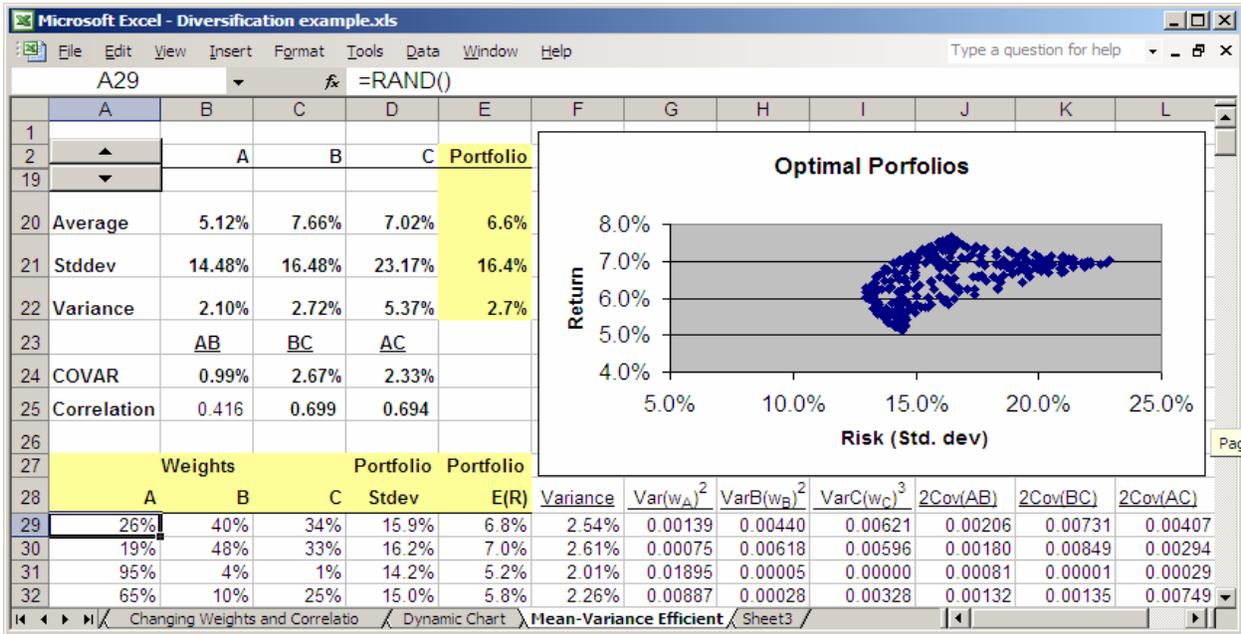
## Monte Carlo Simulations

The ability to generate random numbers from a variety of probability distributions enables users to create simple simulations with Excel. The RAND() function can be used specify portfolio weights and illustrate a simple three stock efficient frontier (see the following page).

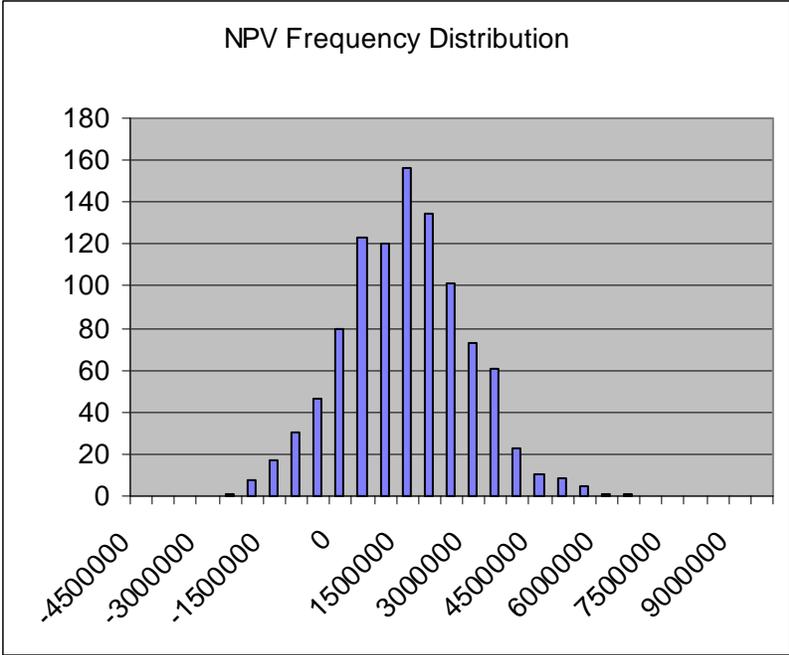
A second, and somewhat more complex illustration, makes use of Excel's random number generator to create a 1,000 iteration Monte Carlo simulation. In this example, the mean and standard deviation of model inputs (selling price, units, and inflation) are specified parameters of normal probability distributions.<sup>6</sup> The random numbers are generated using Excel's data analysis tool which is available as an add-in on the "Tools" menu. While this approach to performing a Monte Carlo simulation is a useful pedagogical tool, its practical applications are limited, as the worksheet requires 1,000 replications of the financial model, rather than performing 1,000 iterations using a single model.

<sup>5</sup> Craig Holden's Dynamic Chart of US Yield Curve Dynamics, Copyright © 2005, Craig W. Holden. All rights reserved. E-mail: cholden@indiana.edu Web site: www.excelmodeling.com. Mail: Professor Craig W. Holden, Kelley School of Business, Indiana University, Bloomington, IN 47405.

<sup>6</sup> Excel allows users to generate random numbers from uniform, normal, Bernoulli, binomial, Poisson, patterned, and discrete distributions. Excel based commercial products such as Decision Engineering's Crystal Ball software allow users to perform simulations, risk analysis, and forecasting tools based on a wide range of probability distributions.



The simulation's output is used to evaluate the project's NPV. The output can be summarized with standard descriptive statistics or illustrated graphically with a frequency distribution.



**CONCLUSION**

This paper illustrates the use of basic Excel features to create rich visual hands on learning tools. The techniques for building dynamic graphs, applying conditional formatting, integrating spinners and performing a basic Monte Carlo simulation are discussed. Self-correcting Excel worksheets provide students with immediate feedback and offer a just-in-time learning experience. Additional advantages include exposing students to the business world's tool of choice for data analysis and financial modeling, and a streamlined grading process.

## Exhibit A

### Creating a basic self-correcting worksheet involves eight simple steps.

1. Build an “initial” worksheet model.

1 Calculate the level of sales in **units** required to reach a \$10,000 target profit. Start at net operating income and work up towards the contribution margin

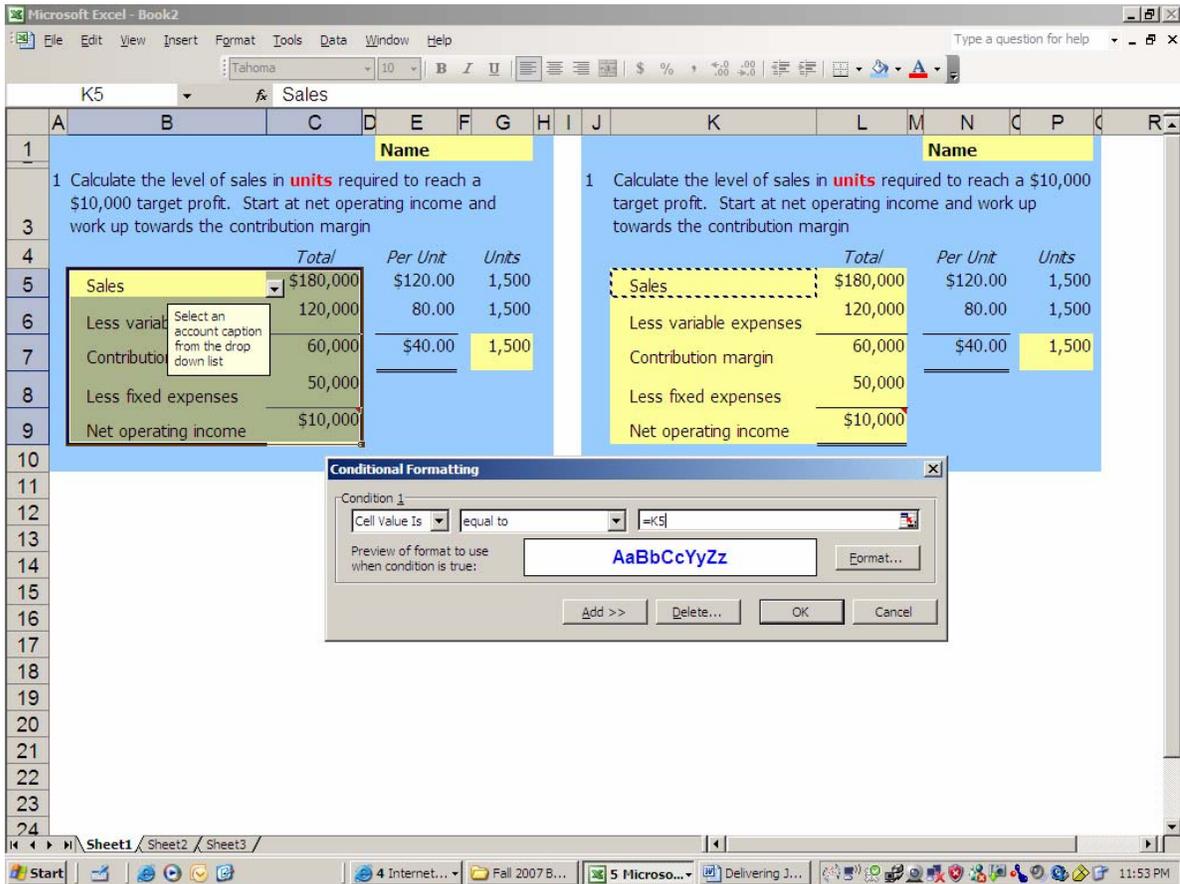
	Total	Per Unit	Units
Sales	\$180,000	\$120.00	1,500
Less variable expenses	120,000	80.00	1,500
Contribution margin	60,000	\$40.00	1,500
Less fixed expenses	50,000		
Net operating income	\$10,000		

2. Skip several columns or rows, and make copy of the “initial” completed model on the same worksheet tab. This copy will serve as the “worksheet’s solution”.

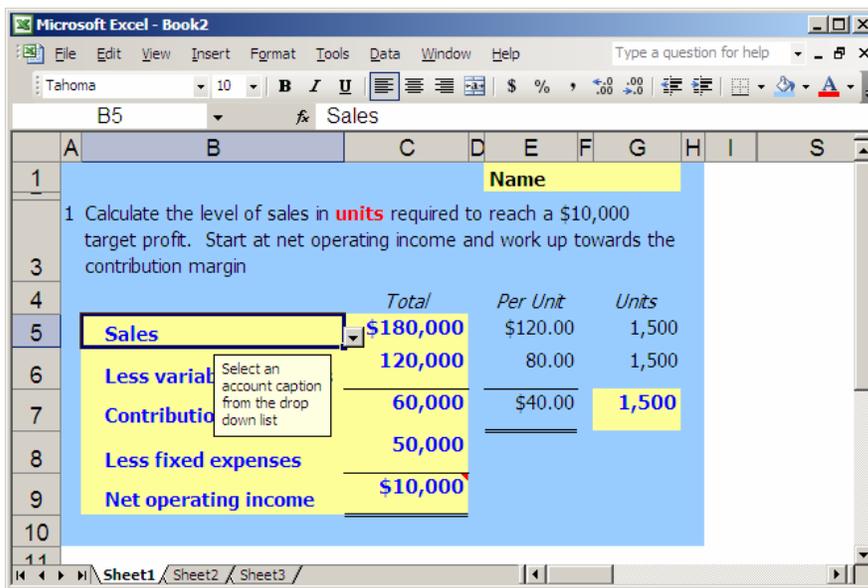
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	Total	Per Unit	Units
Sales	\$180,000	\$120.00	1,500
Less variable expenses	120,000	80.00	1,500
Contribution margin	60,000	\$40.00	1,500
Less fixed expenses	50,000		
Net operating income	\$10,000		

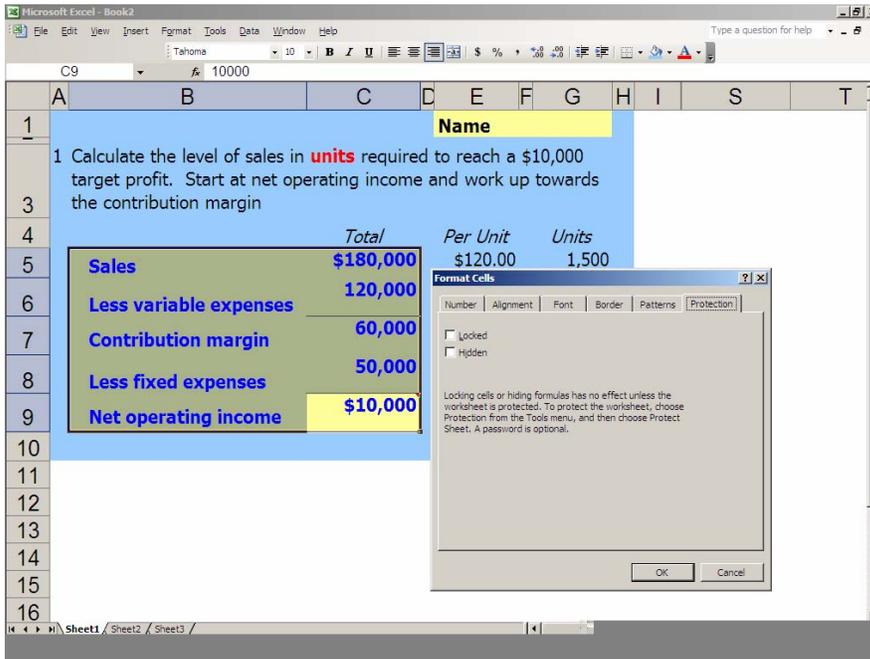
- Select (highlight) the cells containing the initial model and apply conditional formatting to these cells.



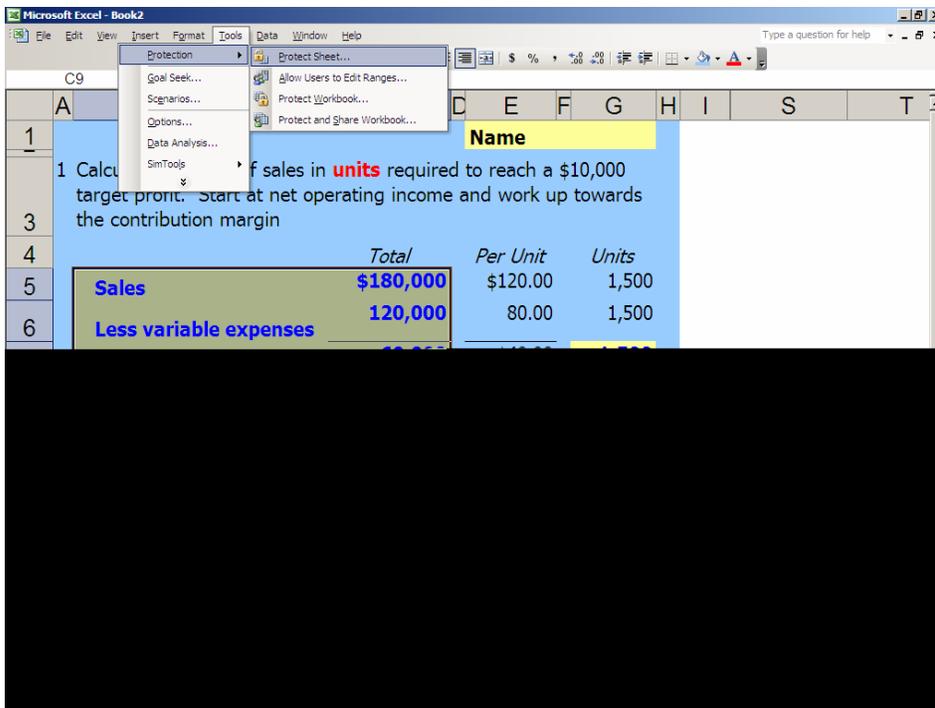
- Hide the columns or rows containing the “worksheet’s solution”.



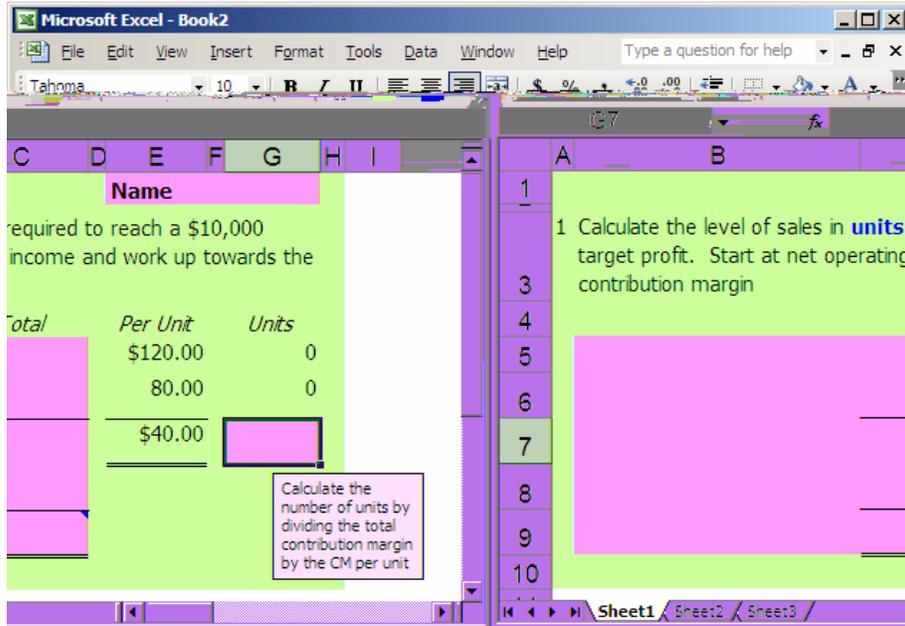
- On the “initial” model, unprotect the worksheet cells that you intend for the students to use for their answers (“answer cells”).



- Protect the Excel worksheet.



7. Delete the answers from the “answer cells”.

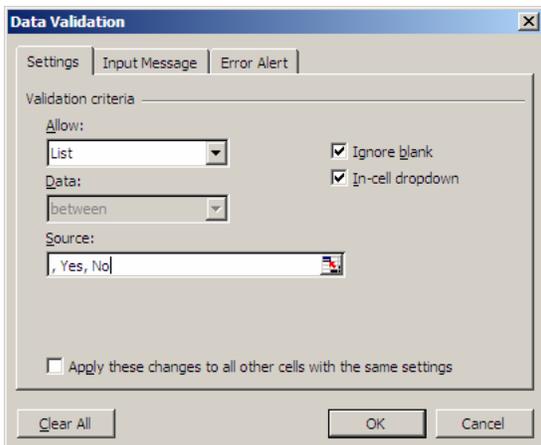


8. Save your self-correcting worksheet.

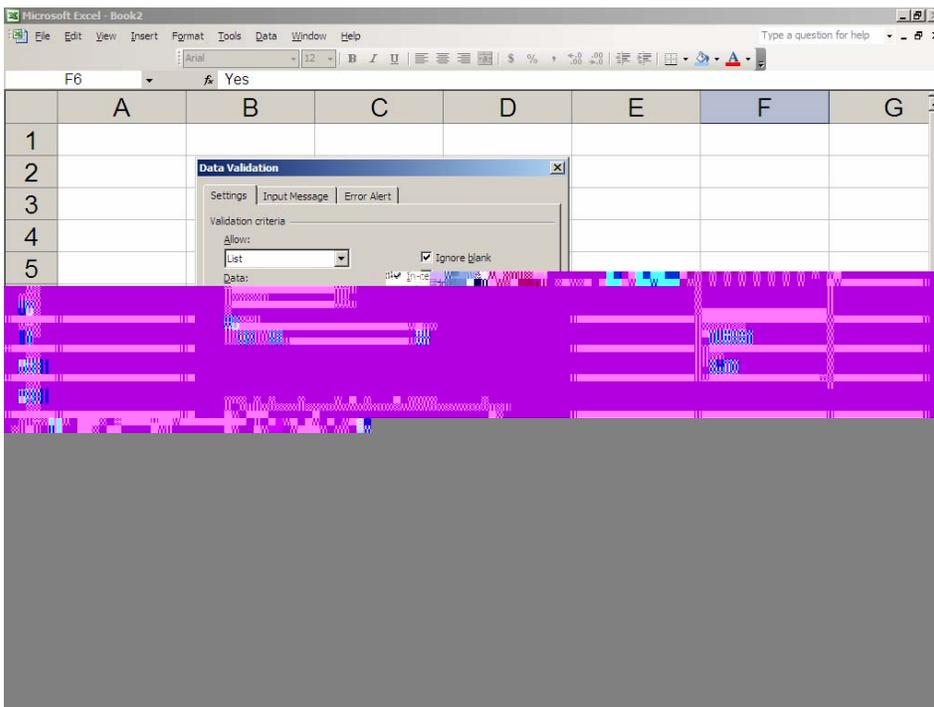
## Exhibit B Creating Drop Down Menus.

Drop down menus are created with Excel's data validation feature, which is accessed by selecting "Data" from Excel's main menu, followed by "Validation". On the "Settings" tab a list of potential cell inputs is created. The validation criterion is a "List" and the "Source" can take one of two forms.

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