

Homework 21

Begin with the file [Homework 21 Source File.xlsm](#). Follow the directions in Part A (5 pts), Part B (5 pts), Part C (5 pts), and Part D (5 pts). When you are finished, save the Excel file and PowerPoint files and attach them in Blackboard. You will need the end product from this assignment to work on your take-home assessment, so don't skip this lesson!

It is strongly recommended that you print out these instructions prior to starting the assignment, as going back and forth between this pdf and Excel may cause some programmatic trouble.

Introduction

One field of engineering is Systems Engineering, which includes areas such as logistics. In this exercise, you will assume the role of a systems engineer working on a team that is putting together a proposal. One section of that proposal included maintenance costs. Your team is constantly revisiting various aspects of the system to drive down maintenance costs, so every day you're getting new numbers.

One of your responsibilities is to determine the number of "spare parts" needed to maintain the system. The math required to determine the spares is straightforward.

There is a set number of operating hours that the customer expects to use the system annually. There is something else called a "Confidence Factor," which is usually set to 95%. A confidence factor is essentially, if an item on the system breaks and you go to the spares box, what's the probability that there is a spare part there.

Think: If you run out of paper towels, you want to be 95% sure that there are more paper towels in the pantry. That's a confidence factor.

Confidence factors are expressed as percentages from 1% to 99%

Example: You can never be 100% sure that something's going to be there, so your confidence factor always has to be less than 99.999999999%. We simplify this by just limited our factors from 1% to 99%.

Confidence factors are associated with values from the Normal Distribution table, which you will study in Statistics. For our purposes, we can just get the associated values using a function in Excel ([normsinv](#)). That's all you really need to know about that for this exercise.

Each item in the system has an average length of time between failures. This is called Mean Time Between Failures (MTBF). Each item also has a time required to repair, or Repair Turn Around Time (RTAT).

To calculate the spares needed, you figure out how many more items are going to fail while you're fixing the first one that broke. This is called Fails per Turn Around Time (FTAT).

The table below summarizes the calculated items and their formulas.

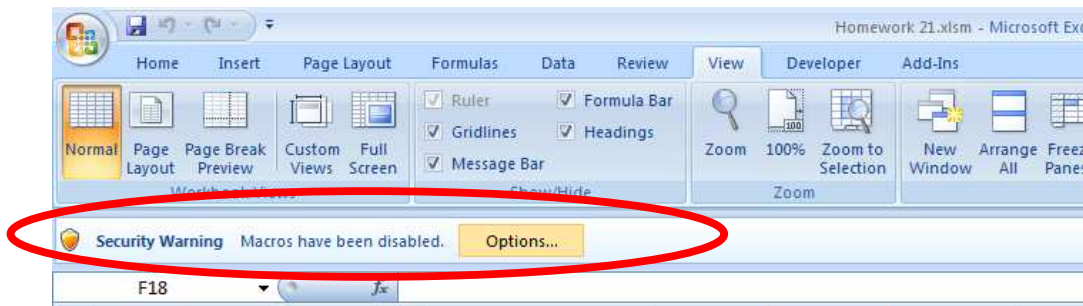
Calculated Item	Formula
Annual Fails	$Operating\ Hours / MTBF$
Fails per Day	$Annual\ Fails / 365$
Fails per Turn Around Time	$Fails\ Per\ Day * RTAT$
Spares Needed*	$FTAT + normsinv(Confidence_Factor) \cdot \sqrt{FTAT}$

*We always round up Spares Needed to the next integer. The associated Excel function is **Roundup**.

Think: If you need 1.5 spare parts, then you need to buy 2. Even if you need 1.2 spare parts, you still need to buy 2.

Part A: Setting up the Basics

For your first task, open **Homework 21 Source Data.xlsm**. Note that this is an “Excel Macro-Enabled Workbook,” which you can tell by the **.xlsm** extension. Normal Excel workbooks have a **.xlsx** extension. When you open the workbook, you will probably get an error like the one pictured below. Be sure and click **Options...** and **Enable this Content** in the next dialog box. Then click **OK**.



Now, recreate the spreadsheet pictured below on a tab titled **Main** using the information in the narrative above. Anything highlighted in yellow is input, anything else is output. Since you have the same input, your calculated values should all be the same. To check your work, make sure your total spares cost is \$661,797.

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2												
3		Annual Op Hours	1000									
4		Confidence Factor	95%									
5		Total Spares Cost	\$661,797									
6												
7		Item Description	MTBF	Item Cost (\$)	RTAT (days)	Fails Per Year	Fails per Day	Fails per TAT	Spares Needed	Rounded Up Spares	Spares Cost	
8		Altimeter	280	\$ 30,493	30	4	0.010	0.2935	1.18	2	\$ 60,986	
9		Flow Meter	184	\$ 27,833	45	5	0.015	0.6700	2.02	3	\$ 83,499	
10		Checkvalve	288	\$ 49,634	45	3	0.010	0.4281	1.50	2	\$ 99,268	
11		Incendiary Device	192	\$ 22,280	45	5	0.014	0.6421	1.96	2	\$ 44,560	
12		CPU	156	\$ 24,298	45	6	0.018	0.7903	2.25	3	\$ 72,894	
13		Inertial Measurement Unit	241	\$ 45,763	45	4	0.011	0.5116	1.69	2	\$ 91,526	
14		Power Supply 1	106	\$ 25,986	30	9	0.026	0.7754	2.22	3	\$ 77,958	
15		Power Supply 2	122	\$ 43,702	45	8	0.022	1.0106	2.66	3	\$ 131,106	
16												
17												

Part B: Performing a Sensitivity Analysis

Your boss wants to know how the numbers will change if they decide to tweak the confidence factor. (This is called a Sensitivity Analysis, since it shows how sensitive the cost is to a change in input.) Create a new tab called “**Confidence Comparison.**” Next, create a table similar to that shown below.

	A	B	C	D
1				
2				
3		Confidence Factor	Total Spares Cost	
4		50%		
5		55%		
6		60%		
7		65%		
8		70%		
9		75%		
10		80%		
11		85%		
12		90%		
13		95%		
14		99%		
15				

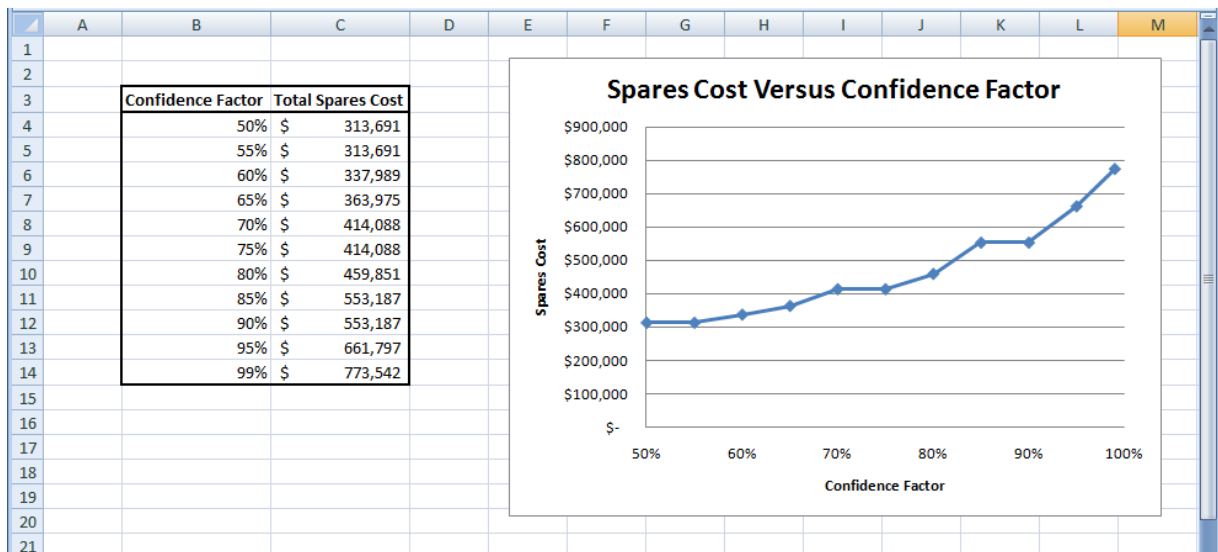
By changing the confidence factor in **Main**, determine what the spares costs would be at each confidence level.

*Hint: Each time you change the confidence level, copy the spares (using **Ctrl-C**) cost off the **Main** spreadsheet, and then right-click in the cell where you want to paste the information. A pop-up menu appears. Click **Paste Special...** and select **Values**. Then click **OK**.*

Your numbers should match those below.

	A	B	C	D
1				
2				
3		Confidence Factor	Total Spares Cost	
4		50%	\$ 313,691	
5		55%	\$ 313,691	
6		60%	\$ 337,989	
7		65%	\$ 363,975	
8		70%	\$ 414,088	
9		75%	\$ 414,088	
10		80%	\$ 459,851	
11		85%	\$ 553,187	
12		90%	\$ 553,187	
13		95%	\$ 661,797	
14		99%	\$ 773,542	
15				
16				

Finally, create a chart that plots the cost versus the confidence factor. You may need to change the limits on the x-axis. Note that you should use **Scatter with Straight Lines and Markers** instead of **Scatter with Smooth Lines and Markers**. Using smooth lines will misrepresent the data. (Try it out – can you see the difference?)



Part C: Recording a Macro

The numbers are changing. It seems like every afternoon the reliability specialists have different MTBFs. You've now got three different sets of MTBFs, and your boss wants to see charts on all of them.

So that you don't have to do everything over and over, we'll do it one more time, but we'll record a macro.

You can watch a video of the following steps at:

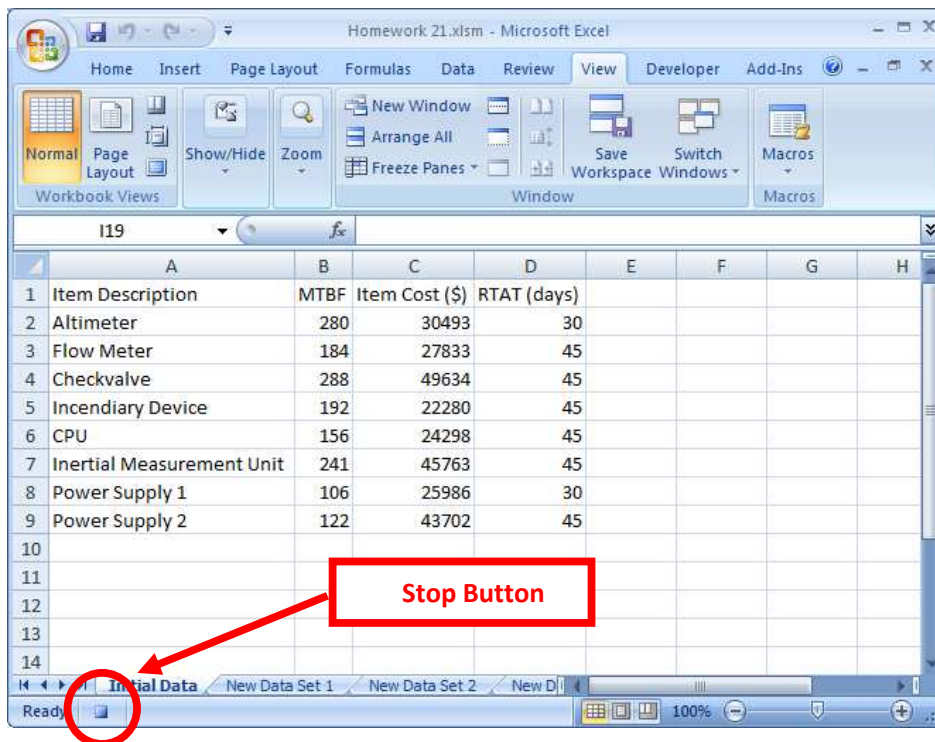
<http://media.mclennan.edu/flv/YWY3N2RkNWE3NmE5ODc0MjEyNjQwMDQy>

First, copy the information using the **Paste Special... Values** option into the **Main** spreadsheet.

Now, we're going to start recording the macro. In the **View** ribbon, click the arrow under **Macros** and select **Record Macro...** Name the macro **Confidence_Comparison** and in the shortcut key box type **C**. Click **OK**.

Starting now, anything that we do in Excel will be recorded. Any keystroke, any cell we select, *anything* will be recorded.

Note that there is now a stop button somewhere on your screen. (Exact placement may be different, depending on your settings.) Don't click it now, but eventually, when we are done recording our actions, we will stop the recording by hitting the stop button.



Now, we are going to go between this **Main** sheet and the **Confidence Comparison** sheet, changing the confidence value and copying the spares cost from one to the other. But this time, all our actions will be recorded. Once you have changed all the confidence values, set the main confidence value back to .95 and hit the stop button.

*Hint: If you make a mistake any time when you are recording, use **Ctrl-Z** to undo the incorrect action. This is better than simply fixing the mistake, because using **Ctrl-Z** actually deletes the incorrect action in the macro. If you type a .5x instead of .5, for example, and then delete the incorrect value and retype it, all those extra steps will be in the code. That is, every time you run the macro, the computer will type a .5x, delete it, and replace it with a .5. To avoid this kind of silliness, use **Ctrl-Z**.*

You now have a new chart with all the updated values, and you have a macro that will create the table and update the graph for you in the future, any time you want it.

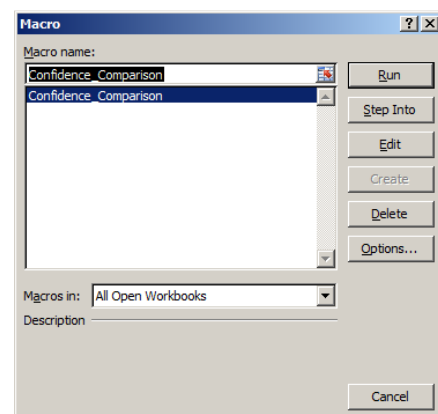
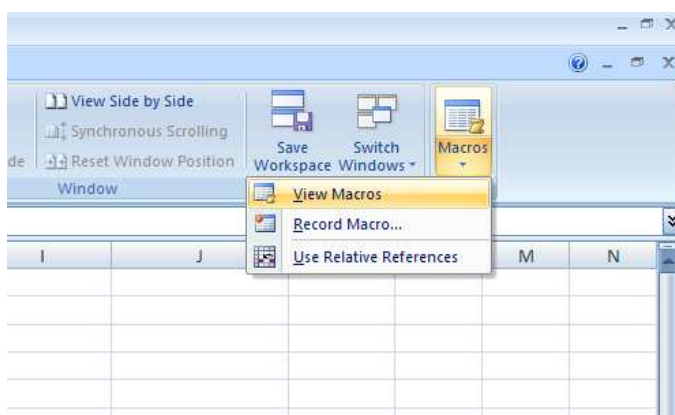
Part D: Using a Macro

Since it is proposal time, and the company's future is on the line, everyone is running around like crazy gibbons. Your boss now wants the confidence comparisons for all four data sets. Create a PowerPoint Presentation with four slides titled "Initial Data", "New Data Set 1", "New Data Set 2", and "New Data Set 3". Underneath the title you should paste a copy of the comparison graph for the corresponding data set.

In case you haven't already, save your file. In general, you always want to save a file before running a macro, in case you accidentally mess something up.

You will need to recreate the table for the first data set. Copy and paste the data set into the **Main** sheet. To run the macro, start on the **Main** sheet, click the drop-down arrow under **Macros** in the **View** ribbon and select **View Macros**. Select **Confidence_Comparison** and click **Run**.

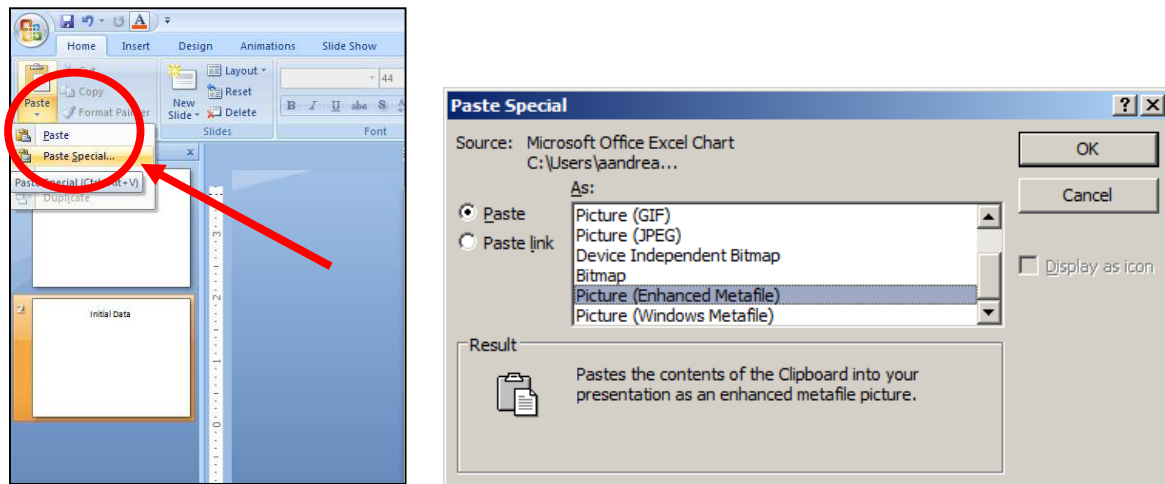
*Note: If you are not on the **Main** sheet when you run the macro, you will get all sorts of gobbedly-goop for an answer. If this happens, close the workbook without saving, and try again.*



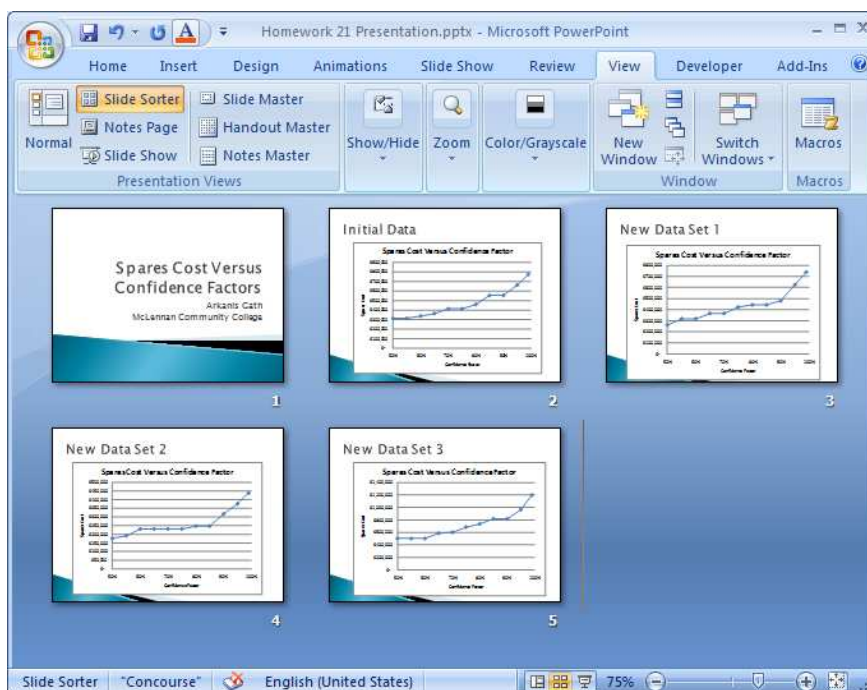
Once you get the updated chart, you should paste it into the PowerPoint slide using **Paste Special...**, which is accessible by clicking the down arrow beneath the **Paste** button. Select

Picture (Enhanced Metafile). If you do not paste the chart as a picture, it will change any time the data in your Excel file changes.

After you've completed your four data slides, create an appropriate title slide and design for your presentation.



Your PowerPoint presentation should look something like this:



Save your presentation as **Homework 21 Presentation.pptx** and close PowerPoint.