EXCEL BEST PRACTICES

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N.B. Version Relevance:

Some of the information contained in this document dates back to earlier versions of Excel. However, in the context of "best practices", it is still quite relevant. As well, updates for the current latest versions (Excel 2021/Microsoft 365) have been added to this document.

Recent estimates indicate that, worldwide, there are over a billion users of Microsoft Excel.
Like it or not, Excel is ubiquitous in business; used at every level in the company organization chart. Excel is often a required pre-requisite for many job applicants; it's becoming more and more common in schools and universities. Even the casual user at home has practical needs for Excel for things like arranging soccer league schedules and activities for your kids, to keeping track of home cash flows and personal investments, to planning and organizing a wedding party; the uses are nearly endless.

For business purposes, Excel is depended upon as a tool which supports information which can end up in company quarterly/annual statements, marketing materials, customer price lists, etc. Oftentimes, Excel even serves as the primary application for financial accounting, budgeting, costing, and profit & loss Analysis. And since most Excel users are self-taught, having learned by doing, and are definitely not programmers, these users will occasionally find themselves with an Excel task that is causing frustration, headaches, or worse. Workbooks and worksheets may become unwieldy; there may be errors which are hard to find or even unknown; following worksheet logic may be next to impossible; users may find themselves spinning their wheels trying to get their spreadsheets completed; and getting others to understand your spreadsheets? fuggedaboudit.

As a result of all this, independent studies have shown that a significant percentage of spreadsheets actually have material error. These problems can be alleviated if users would simply follow some "Excel Best Practices" as detailed in this paper. A few of these may be common-sense but most require a good understanding of Excel in order to be useful.
Any questions about these – JUST CONTACT ME.

INTRO

- Many Excel users build spreadsheets without planning, leading to inefficiency and poor design and hard-to-understand information, not to mention flaws/errors

Excel is, arguably, the most-used software application on the planet, after email. However, many people often design their spreadsheets with little or no planning. This means their spreadsheets may have flaws, errors, run inefficiently. Perhaps the #1 rule when designing a spreadsheet is, should ***start*** with the ***end*** in mind and never assume you will not need to add more data or formulae to your spreadsheet, because, the chances are that you will. A good spreadsheet should have about 80% planning and 20% implementation. While this may seem surprising, I can assure you that *the long term gain will far outweigh the short-term pain*. Remember that spreadsheets are about giving **correct** information to the user, not possible erroneous information that looks cool and sexy. Let's look at how a spreadsheet should be set up efficiently.

EXCEL BEST PRACTICE & DESIGN (TABLE OF CONTENTS) GOTO TOP

1. ROWS LIMIT (Shame On *Microsoft*)
2. FORMATTING (The Least Important Aspect)
3. FIND THE LAST USED ROW (Avoid wasted space)
4. LAYOUT (**THE** Most Important Aspect)
5. FORMULAE (This Is What It Is All About)
6. SPEEDING UP RE-CALCULATIONS (How-To, Do's & Don'ts)
7. ARRAY FORMULAS (PRIOR TO EXCEL 365)
8. Array Formulas (Excel 365 and later)
9. UDFS OR CUSTOM FUNCTIONS (Rarely Required)
10. VOLATILE FUNCTIONS (Avoid These)
11. LOOKUP FUNCTIONS (How To Speed Up)
12. MICROSOFT'S TIPS FOR OPTIMIZING SPEED (From The Horse's Mouth)
13. ACKNOWLEDGEMENT

ROWS LIMIT BACK TO MENU

- Excel includes more rows than it can effectively handle, especially in large datasets (incredibly, 1,048,576 rows by 16,384 columns)
- Overfilling rows can impede performance, even corrupt workbooks

There's bad news and good news:

The bad news is that the very 1st thing you SHOULD know is that Excel **contains far more rows and columns than can be effectively handled.** Why Microsoft continues to mislead its users by supplying far more capacity than most PCs can handle remains a mystery. Perhaps, it impresses the uninformed. Don't let that be YOU. If you try to fill just 1 column using all rows, save and close, you might very likely never be able to open the Workbook again. This sounds like a severe limitation, doesn't it !

The GOOD news is that this limitation DOES NOT MATTER because you can still load humongous-sized datasets into Excel !

A not-well-publicized feature in Excel that has been around since version 2013 is the Data Model. The Data Model is an in-memory relational data engine that lets you integrate, relate, and analyze large datasets from multiple sources directly within Excel using tools like Power Pivot and Power Query. Both Power Pivot and Power Query have been part of Excel since 2013. Power Query is an EXTREMELY powerful, yet easy-to-use dedicated data import/cleansing/transformation tool.

The point is, using Power Query, you can load millions of records into the Data Model. Then, using Power Pivot, or just a standard Pivot Table, you can analyze and report on the data just as you normally would.

The practical limit for loading data into Excel's Data Model via Power Query is typically about 2-3 million records (rows) — comfortably and efficiently.
Technically speaking, a 64-bit processor can handle up to tens of millions of rows, limited by:

- Available RAM (8–16 GB minimum recommended, 32 GB+ ideal)
- Complexity of data (number of columns, relationships, calculated columns/measures)
- Other open apps competing for memory
- A 32-bit processor has a hard limit of 2GB of memory; as such, Excel will start to choke at around 300-500K rows

Tips to Improve Performance:

- Load only needed columns
- Use Power Query to filter and pre-shape data before loading
- Avoid complex calculated columns in the Data Model
- Use measures (with DAX functions, in Power Pivot) instead of calculated columns where possible

SPREADSHEET FORMATTING BACK TO MENU

- Over-formatting impacts efficiency and increases file size; stick to simple formatting (black, white, grey).
- Avoid using "Text" cell format unless absolutely necessary; it can break formulas and cause misalignment in data types.

While a spreadsheet should be easy to read and follow, this should rarely be at the expense of efficiency. I myself am a big believer in '**Keep it simple, Stupid**' (K.I.S.S). Far too many people spend about 30%, or more, of their time formatting their spreadsheets. This time (although they don't realize it) often comes at the expense of efficiency and accuracy. Often the overuse of formatting adds size to your Workbook and while it may look like a work of art to you, it may look terrible to another. Some very good universal colors are black, white and grey.

Only ever use the cell format of **Text if really necessary**. This is because all data entered into the cell becomes text and spreadsheets are all about numbers. Worse still, is any cell housing a formula which is referencing a Text formatted cell, will also become formatted as Text. Believe me, you do not want formula cells to be formatted as Text! **This format is VERY rarely <u>needed</u>, yet frequently occurs.**

If you apply a number format to specific cells try to **not** apply the format to the **entire** column. If you do, Excel will assume you are using these cells. This can give unexpected results when locating the last used cell. With over 1 million rows in a single worksheet, it won't take too long before you have told Excel that you are using millions of cells, when in reality the number is only in the thousands! Having said not to format entire columns & rows, **it should be noted that intermittent & sporadic formatting to individual cells can increase file size.**

If you want your formatting to automatically apply to new data, either use the "**Format Painter**" (paint brush icon on the formatting toolbar). Or go to **Tools**>**Options** | **Edit** and check "**Extend list formats and formulas**" (checked by default; this will *format new items added to the end of a list to match the format of the rest of the list. Formulas that are repeated in every row are also copied. To be extended, formats and formulas must appear in at* ***least three of the five last rows preceding the new row.***

FIND THE LAST USED ROW BACK TO MENU

- Excel's "last cell" feature is unreliable due to saved formatting and content history.
- Use VBA code to accurately determine the true last used row on a sheet.

You can use **Edit>Go to-Special-Last cell** to try and find the last cell in the active sheet, but it is **not very reliable**. The reasons are two-fold:

1. **The last cell is only re-set when you save**. This means if you enter any number or text in say, cell A10 and A20 of a new Worksheet, then delete the content of A20, the **Edit>Go to-Special-Last cell** will keep taking you to A20, until you save.

2. **It picks up cell formatting**. Let's say you enter any text or number in cell A10 and then enter a **valid date** in cell A20 of a new Worksheet. Now delete the date in cell A20 and save. The **Edit>Go to-Special-Last cell** will still take you to A20. This is because entering a date in A20 has caused Excel to **automatically** format the cell from "**General**" to a Date format. To stop from going to A20 you will have to use **Edit>Clear>All** and then save.

So when using VBA you cannot rely on:

```
Range("A1").SpecialCells(xlCellTypeLastCell).Select
```

Below is a method that will find the REAL last used row

Find the last used Row on a Worksheet:

```
Sub FindLastRow()
Dim LastRow As Long
        If WorksheetFunction.CountA(Cells) > 0 Then
                'Search for any entry, by searching backwards by Rows.
                LastRow = Cells.Find(What:="*", After:=[A1], _
                        SearchOrder:=xlByRows, _
                        SearchDirection:=xlPrevious).Row
                        MsgBox LastRow
        End If
End Sub
```

Another common mistake with cell formatting is the changing of alignment of cell data. By default, **numbers are right** aligned and **text is left aligned,** leave it this way! If you Start changing this, you will not be able to tell at a glance if the contents of a cell is either text or numeric. It is very common for people to reference cells, that look like numbers, when in reality they are text. If you have altered the default alignment, you will be left scratching your head. *Perhaps the exception to this rule is headings.*

Merged cells are (in my opinion) to be avoided. The Microsoft Knowledge base is full of frequently encountered problems with merged cells. As a good alternative use "**Center across selection**" found on the **Alignment** tab of the **Format cells** dialog under "**Horizontal**".

SPREADSHEET LAYOUT BACK TO MENU

- Use a flat-file structure: place all raw data in one worksheet, in table format with rows for data and columns for fields.
- Avoid blank rows/columns in data regions and ensure data is sorted to optimize formula performance.

When setting out your data, follow these golden rules as closely as possible.

- ***"Less is More" – Use LESS Worksheets/Workbooks; it makes Analyzing/Reporting A LOT Easier.*** Try And Ensure All Related Raw Data Is On 1 Worksheet And In 1 Workbook. The Number 1 Issue With Excel Spreadsheets Is Users Spreading Raw Data Over Many Worksheets And/Or Workbooks.
- All Layouts SHOULD Contain 1 Single Worksheet In A Table Format Of **RAW DATA**. From This **Raw Data** Comes Your **FINAL Data**.

- ***When Putting In Headings Bold The Font***. This Will Help Excel Recognize Them As Headings When You Use One Of Its Functions E.g.; **Sort**.
- ***When Putting Data Into The Data Area Of Your Spreadsheet Try To Avoid Blank Rows And Columns.*** This Is Because A Lot Of Excel's Built-In Features Will Assume A Blank Row Or Column Is The End Of Your Data. It Can Also Help With A Lot Of Excels Formulas. Having Said This Though, It Is A Good Idea To Leave **At Least** 4 Blank Rows Above Your Headings (Hide Them If You Wish), These Can Then Be Used For Keeping Totals (Much Better Than Being At The Bottom) And Criteria For Some Of Excels Built In Features, E.g. Advanced Filters.
- ***Have Your Data Sorted Whenever Possible***. Excel Is Very Rich In What Is Known As Lookup & Reference Formulas And Many Of These May Rely On Your Data Being Sorted In A Logical Order. It Will Also Greatly Speed The Calculation Process Of Many Functions.
- ***Use Real Dates For Headings And Format Them Appropriately***. By This I Mean If You Want The Names Of The Months As Headings Type Them In As 1/1/2001 , 2/1/2001 , 3/1/2001 etc., then Format Them As "**Mmmm**". This Is A Very Simple Procedure That Is All Too Often Overlooked By Many. If You Have Real Dates As Headings Life Will Be Much Easier later If You Need To Use Them In Formulas.
- ***Don't Put In One Cell What Could Go In More Than One Cell***. Say You Have The Names Of 100 People To Put Into Your Spreadsheet, Don't Put Their Full Name In One Cell. Instead, Put The First Name In One Cell And Their Surname In The Next Cell To The Right. If You Need To Place Them Into One Single Cell At A Later Stage, This Can Be Done Very Easily - The Same Cannot Always Be Said For The Reverse.
- ***Place Your Headings Across Columns And Your Data In Rows Directly Underneath***. Remember That Excel Has Far More Rows Than Columns. Excel Expects Your Data To Be Laid Out This Way.

If you can stick to these guidelines you will thank yourself later as you will then easily be able to use many of Excels powerful built in features, which often need the data laid out this way.

SPREADSHEET FORMULAE BACK TO MENU

- Avoid referencing entire columns in formulas—it drastically slows Excel down.
- Use dynamic named ranges to manage growing data efficiently without over-referencing unused cells.

See also: EXCEL FORMULA ERRORS.

This is the biggest part of any spreadsheet! Without them you really only have a document. Excel has over 300 built in Functions (with all add-ins installed), but chances are you will only use a handful of these.

The number one mistake made in regards to formulae in Excel is the referencing of **entire columns**, this is a big mistake! This forces Excel to look through potentially thousands, if not millions, of cells which it need not be concerned with at all. *Although later versions of Excel are getting smarter at detecting 'dirty cells'*. Assume, for example you have a table of data ranging from cell **A1** down to **H1000**. You may decide that you want to use one or more of Excel's look-up formulas to extract the required information. As your table may be growing, as new data is added, it is common to reference the entire table incorporating all rows. In other words, your reference may look something like "**A:H**", or possibly **A1:H65536** (the row limit for v2003.) The reason this is done is so that when new data is added to the table it will automatically be referenced in the formulas. This is a **very bad habit** to form and should be avoided in most cases. This obviously poses the problem that if you do not do this, you will constantly be needing to update your formula references to incorporate the new data as it is added to the table.

Possibly one of the very best ways to overcome this is to familiarize yourself with the use of dynamic named ranges. If you are not familiar with these, check them out here: **DYNAMIC RANGES** *Please note that for the purpose of being totally generic, the examples of dynamic ranges reference entire columns, there is most likely no need for this in your own spreadsheet. I often play it safe and reference about 300 more rows than I think I will need.*

READ THE TEXT BELOW FROM THE MICROSOFT KNOWLEDGE BASE

Calculate Message Remains in Status Bar If 65,536 Formula References

Microsoft Excel calculates during different events like column auto-resizing, when entering anything in any cell, and so forth. However, Excel can only track 65,536 dependencies to unique references for automatic calculation.

After the workbook has passed this limit, Excel no longer attempts to recalculate only changed cells. Instead, **it recalculates all cells after each change**. This behavior is by design of Microsoft Excel.

Microsoft Excel will correctly calculate all formulas. However, the "**Calculate**" message in the status bar indicates that Microsoft Excel can no longer track the formula dependencies and is calculating every formula in the workbook after each change. If you are unsure when the last calculation event took place and you want to be sure your formulas are up to date, simply Start a calculation manually. To do this, press **CTRL**+**ALT**+**F9** and wait until "**Calculating Cells: *n*%**" disappears and "**Calculate**" returns to the status bar.

SPREADSHEET SPEEDING UP RE-CALCULATIONS BACK TO MENU

- Manual calculation mode is risky; it's better to fix inefficient design than rely on manual updates.
- Top culprits for slow recalcs: array formulas, SUMPRODUCT, UDFs, volatile functions, and poorly structured lookups.

A common problem with poorly designed spreadsheets is that they become painfully slow in recalculating. Many people will suggest that a solution to this problem is putting a calculation into manual mode via Formulas/Calculation Options/Manual.

Note that this can be risky if users aren't careful to reset the mode to auto-calc when necessary. Basically, when doing data input/edits in such cases, use manual mode, but then be careful to switch back to auto-calc mode when done or else your calculations won't update.

Below is a list of what is often the worst offenders for slowing down recalculations of spreadsheets.

- Array Formulas (the old version)
- Sumproduct function
- UDFs (User-Defined Functions)
- Volatile Functions
- Lookup Functions

Let's look at each of these now in turn, and see what alternatives we can have for them.

SPREADSHEET ARRAY FORMULAS (prior to Excel 365) BACK TO MENU

- Many (not all) such functions require CSE (Ctrl-Shift-Enter) to execute the formula rather than just Enter
- Avoid array formulas on large ranges—they recalculate cell-by-cell and are inefficient.
- Use alternatives like database functions or PivotTables for better performance and clarity.

A potential alternative for array formulas, are Excel's Database functions, e.g. DSUM, DCOUNT, et. al. Perhaps a better alternative, in most cases, is the single greatest feature of Excel – Pivot Tables.

If you're trying to learn Pivot Tables on your own, or asking a colleague to teach you, or spending hours on Youtube, you might get frustrated. I can promise you that it wouldn't take me more than 3 hours to enable a motivated individual to completely understand what Pivot Tables are and how to set them up, and then another 3 hours to become really comfortable with building Pivot Tables on their own, including slicers, charts, and dashboards.

If you ever need to manage and report on lots of data in an effective manner, once you master Excel's Pivot Tables, you will wonder how you survived without them!

Perhaps the biggest problem with array formulae is that they look efficient, but when compared to an alternative, nothing could be further from the truth! An array formulae must follow rules that Excel's built in Functions do not have to, that is they **must** loop through each and every cell they reference (one at a time) and check them off against

a criteria. For this reason arrays are best suited to being used on single cells or referencing only small ranges.

SPREADSHEET ARRAY FORMULAS (Excel 365 and later) BACK TO MENU

- Excel 365's new dynamic array functions are significantly more efficient than the old CSE (Control+Shift+Enter) array formulas
- CSE formulas were prone to performance hits, especially over large ranges
- CSE formulas recalculated every referenced cell even when unnecessary
- CSE formulas made workbooks fragile and hard to audit/debug

The new dynamic array functions are much better because:

- There's no need for CSE: They spill automatically into adjacent cells, removing the need for forced array entry
- Smarter recalculation: Excel recalculates only the dynamic range needed, not every referenced cell
- Cleaner logic: Functions like FILTER, UNIQUE, SORT, SEQUENCE, and LET are optimized and more readable than their old CSE equivalents
- Better performance: They're built into Excel's modern calc engine — leaner, faster, and less prone to workbook bloat

SPREADSHEET UDFS OR CUSTOM FUNCTIONS BACK TO MENU

- N.B. These are almost never needed and very rare, especially with the later versions of Excel (Microsoft 365 and up)
- UDFs in VBA are usually slower than built-in Excel functions
- Only use UDFs when absolutely necessary, and try to incorporate worksheet functions within them to optimize speed

UDFs for those of you that are not aware, are USER-DEFINED FUNCTIONS that are written with Excel VBA which can then be used in a Worksheet in the same way as any one of Excel's built-in worksheet functions. Unfortunately, no matter how good the person is at VBA who has written the UDF, it is very unlikely that it will perform at the same speed as one of Excel's built-in functions, even if it would be necessary to use several nested functions to get the same result. Often a well written and **efficient UDF function** will incorporate the use of Excel's worksheet functions. By this, I mean you may decide to

write a UDF to replace a function which otherwise would require you to use several worksheet functions nested within each other. The most efficient way to replace the use of several nested worksheet functions (if you must) would be to write a UDF that would incorporate the use of all of the worksheet functions necessary. This way instead of having to repeatedly nest the functions on the Worksheet to get the desired result, you could nest the functions once within VBA (by accessing the WorksheetFunction Object) which would then allow you to use this function in the interface, without the need to repeat the nesting. Most of Excels Worksheet Functions can be used in VBA simply by using: **WorksheetFunction.<Function Name>** or **Application.<Function Name>** if the one you need is not available, there will be a VB equivalent.

SPREADSHEET VOLATILE FUNCTIONS BACK TO MENU

- Volatile functions (e.g., NOW, TODAY, OFFSET) recalculate on every change, which slows performance.
- Minimize their use by storing results in one cell and referencing that cell throughout the workbook.

Volatile functions are simple functions that will recalculate each time a change of data occurs in any cell on any worksheet. Most functions (non Volatile) will only recalculate if a cell that they are referencing has changed. Some of the most common volatile functions used are undoubtedly the **NOW()** and **TODAY()** functions, there are also **OFFSET()**, **CELL()**, **INDIRECT()**, **ROWS()**, **COLUMNS()** to name a few more. If you are going to be using the result of these functions frequently throughout your spreadsheet, avoid the temptation of nesting these functions within other functions to get your desired result (especially array formulae and UDF's). Instead, simply type the volatile function into a single cell on your spreadsheet and reference that cell from within other functions. This alone can potentially cut down on the amount of volatile functions by hundreds, if not thousands.

- Avoid forcing exact matches in VLOOKUP/MATCH when not necessary; sorted data with approximate matches is faster.
- Don't double-up VLOOKUPs in IF/ISNA structures—store result in a helper cell instead to halve function calls.

The biggest mistake users make is the forcing of Excel to look in thousands, if not millions of cells superfluously. One of the best ways to overcome this is via the use of dynamic ranges, e.g. with the OFFSET function.

However, many/most users find OFFSET to be complex and intimidating. For those using Excel version 365 and up, OFFSET is not needed much anymore due to the new dynamic array functions (such as XLOOKUP.)

The other mistake is that the lookup functions (in the case of VLOOKUP, HLOOKUP and MATCH) are told to find an **exact match**. That is, the optional fourth argument ***Range_lookup*** is set to False in both VLOOKUP and HLOOKUP. In the case of MATCH the last optional argument (Match_type) is set to 0 (zero). This means that Excel will need to check all cells until it finds an exact match. If possible, always use True (or omitted) for VLOOKUP and HLOOKUP, or **1** (sort ascending) or **-1** (sort descending) in the case of Match. So, whenever possible, sort your data appropriately. **Sorting the lookup columns is the single best way to speed up lookup functions.**

Another very bad mistake is the double use of the Lookup Function nested within one of Excels Information functions. see example below

=IF(ISNA(VLOOKUP(A15,MyRange,2,False)),"",VLOOKUP(A15,MyRange,2,False))

This formula looks for the value in cell A15; if it isn't found in MyRange, return blank, otherwise, return the value from column 2.

Instead, simply use IFERROR:

=IFERROR(VLOOKUP(A15,MyRange,2,False),"")

Also, with Excel 365, XLOOKUP is better than VLOOKUP.

Last, but far from least, learn how to use Excels **DATABASE FUNCTIONS** . They are very easy to use and are often much faster than their Lookup & Reference counterpart.

MICROSOFT'S TIPS FOR OPTIMIZING SPEED BACK TO MENU

- Use a vertical layout with calculations flowing downward; keep raw data separate from formulas.
- Simplify formulas, limit data tables, and avoid recalculating unnecessary cells to reduce processing load.

In Microsoft Excel, recalculation performance is affected by the way data and formulas are arranged on the worksheet. The following list contains tips for optimizing your worksheet to improve recalculation speed:

- Organize Your Worksheets Vertically. Use Only One Or Two Screens Of Columns, But As Many Rows As Possible. A Strict Vertical Scheme Promotes A Clearer Flow Of Calculation.
- When Possible, A Formula Should Refer Only To The Cells Above It. As A Result, Your Calculations Should Proceed Strictly Downward, From Raw Data At The Top To Final Calculations At The Bottom.
- If Your Formulas Require A Large Amount Of Raw Data, You Might Want To Move The Data To A Separate Worksheet And Link The Data To The Sheet Containing The Formulas.
- Formulas Should Be As Simple As Possible To Prevent Any Unnecessary Calculations. If You Use Constants In A Formula, Calculate The Constants Before Entering Them Into The Formula, Rather Than Having Microsoft Excel Calculate Them During Each Recalculation Cycle.
- Reduce, Or Eliminate, The Use Of Data Tables In Your Spreadsheet Or Set Data Table Calculation To Manual.
- If You Only Need A Few Cells To Be Recalculated, Replace The Equal Signs (=) Of The Cells You Want To Be Recalculated. This Is Only An Improvement If You Are Calculating A Very Small Percentage Of The Formulas On Your Worksheet.
- When A Certain Group Of Formulas Must Be Recalculated A Great Number Of Times, Then It May Be Helpful To Replace The Equal Sign (=) In The Formulas That You Do Not Need To Recalculate With A Unique String That Does Not Appear Elsewhere. The Formulas Without The Equal Signs Will Not Be Recalculated (They Are No Longer Considered Formulas). When Microsoft Excel Has Recalculated The Formulas That Still Contain Equal Signs, Search For The Unique String And Restore The =.

ACKNOWLEDGEMENT BACK TO MENU

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I HAVE EDITED SOME PARTS OF THIS DOCUMENT AS WELL AS ADDING A FEW ITEMS OF MY OWN.

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