Global Financial Modeling Guidelines
Developing best-in-class financial models
PwC’s global modeling network includes over 400 professionals, working as a collaborative team across the globe

PwC combines commercial, technology, data and finance skills to design, build and review models that provide insights for major decision making and analysis purposes.

These Modeling Guidelines are the result of collaboration between modeling teams in more than twenty countries across the PwC global network.

PwC provides training courses on each component of these Modeling Guidelines.

This is a living document that will be updated from time to time to reflect new developments. To confirm the latest version, or to access a non-English version, please go to www.pwc.com.

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If you have any questions, contributions or comments, please contact Toby O’Brien (toby.obrien@pwc.com)
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The PwC Modeling Guidelines are designed to help us build high quality, user-friendly models that minimize the risk of errors and assist in making better business decisions.

**Application of the Guidelines**

- The Guidelines are comprised of:
  - 5 Core Principles
  - 10 Design Best Practices
  - 16 “Axis of Spreadsheet Evil” elements
  - 74 Modeling Guidelines
  - 39 Modeling Considerations.
- The 5 Core Principles govern the content and future development of the Modeling Guidelines and Considerations.
- Modeling Considerations serve to build upon the Modeling Guidelines and may also be practical depending on circumstances.

**Benefits**

- Following the Modeling Guidelines will:
  - Improve vital first impressions of the model(s)
  - Provide a framework in which complicated messages can be easily conveyed to stakeholders
  - Enable users to easily answer their questions
  - Reduce model risk
  - Enable more efficient model review
  - Ensure a basis of consistency for which all users can understand and replicate.

**Controls and policy vs individual skills**

- The vast majority of financial modeling risk can be mitigated if the developer and the user of the model are sufficiently skilled and the model is independently reviewed. As such, PwC has developed a suite of training courses to upskill developers, users and reviewers of financial models.
- As the future users and developers of any financial model are unknown when first designed, PwC’s Modeling Guidelines have been developed on the premise that each model could be used by multiple users with a range of experience, and it’s not possible to rely solely on the skills of advanced developers.

**Technologies and the future**

- These Modeling Guidelines specifically refer to Microsoft Excel given the number of financial models built in Excel; however, these principles can be applied across any financial modeling exercise. As the financial modeling industry evolves towards becoming technology agnostic, PwC has developed new methodologies so it can deliver and review models in many technologies.
- Financial modeling is a dynamic and ever changing discipline. While these Modeling Guidelines have been developed in consideration of future developments, they will continue to evolve as Excel and other technologies change the financial modeling landscape.
Models built using Microsoft Excel can be powerful analytical tools. However, Excel’s flexible platform introduces challenges and risks that the PwC Modeling Guidelines aim to address and manage. The 5 Core Principles below govern the content and future development of the Modeling Guidelines and Modeling Considerations.

**Core Principles**

01. Maximize simplicity, consistency and transparency

02. Minimize risk of errors, misinterpretations or incorrect use

03. Minimize the scope for queries or issues from a model review or audit

04. Provide universal applicability for any time series models

05. Provide a framework for building models that are user-friendly and fit for purpose

Developing best-in-class financial models
Developed over many years, the following 10 Design Best Practices are practical tips to apply when developing any type of financial model. These 10 Design Best Practices are a simplified and practical subset of the most important Modeling Guidelines.

1. Keep it simple and transparent
   - Make the calculations and logic easy to understand.
   - Break formula down into simple, logical, easy-to-follow calculations.
   - Avoid hiding any rows, columns or sheets.

2. Identify and separate inputs, calculations and outputs
   - Separate input cells and format them so they are clearly identifiable.
   - Locate inputs in their own cells and do not include constants hardwired within a formula.
   - Keep inputs, calculations and outputs separate from each other.
   - Treat any links to external workbooks as inputs and identify them with consistent formatting.

3. Format in a clear and consistent manner
   - Introduce consistent cell and sheet formatting to improve user comprehension.
   - Include a format key to explain formats to model users.
   - Apply formatting consistently throughout the model.

4. Use structured and descriptive labeling and units
   - Ensure every row has an accurate and useful label.
   - Name each sheet clearly and consistently.
   - Clearly identify the units of every line item.

5. Keep the flow natural: left to right, top to bottom
   - Ensure sheet calculations flow intuitively, from left to right and top to bottom.
   - Organize model content into logical groupings of sheets and sections.

6. Use consistent column headings throughout the model
   - Assign each column a clear purpose.
   - Each time series should use the same column in every worksheet.
   - Do not mix different periodicities in a single worksheet and always use the same column for the first period of each, irrespective of periodicity.

7. Use one unique formula per row that is copied across
   - Ensure logic is always in the one consistent place in each row.
   - Prevents copying over mid-row formula changes.
   - Makes reviewing/testing future maintenance easier and safer.
   - Use the same formula for Actuals and Forecast periods in the same row.

8. Make extensive use of error checks
   - Use error checks frequently throughout the model to check that it is internally consistent and produces logical outputs.
   - Link all error checks to a central location that instantly alerts the model user on every sheet if an error occurs.

9. Include table of contents, user instructions and explanations
   - Include a description setting out the model purpose, functionality and limitations.
   - Make user instructions clear and simple.
   - Summarize the content of the model in a table of contents.

10. Avoid high risk functionality or outputs
    - Avoid circular references and volatile functions such as INDIRECT & OFFSET as they introduce a high risk of error, are difficult to check, and reduce calculation speed.
    - Ensure outputs are free from logic issues and the model does not contain logic errors including #REF!, #DIV/0!, and #NUM!

Our experience suggests that when a model adheres to these Design Best Practices, the likelihood of errors within the model is significantly reduced.
The Axis exists to warn financial modelers about the risks of using certain elements within Excel. These elements should be avoided unless there are no safer alternatives available.

01 Circular references
- There is no guarantee it will iterate to a correct solution, and may reach different solutions depending on the starting point.
- Cannot tell if a second circularity is introduced.
- Slow to recalculate.
- Very difficult to troubleshoot if an error is introduced.
- There are alternative methods of calculating materially accurate model inputs.

02 OFFSET
- Volatile functions increase calculation time, increase memory usage and will always recalculate, even if all precedents are unchanged.
- ‘Trace Dependents’ functionality will not identify a volatile function as dependent, thus implying they are redundant cells.
- The ‘Trace Precedents’ functionality will identify only cells within an OFFSET function and may be different to the actual precedents of the OFFSET function.

03 INDIRECT
- Volatile functions increase calculation time, increase memory usage and will always recalculate, even if all precedents are unchanged.
- ‘Trace Dependents’ functionality will not identify a volatile function as a dependent, thus implying they are redundant cells.
- The ‘Trace Precedents’ functionality will identify only the cell(s) within the INDIRECT function and not the actual precedents of the INDIRECT function.

04 Custom formats to change units
- It is reasonable to assume that ‘what you see is what you get’.
- If these values are used elsewhere, a user will assume they contain the displayed values.
Axis of Spreadsheet Evil

Medium risk

- Normally avoid, but there are specific circumstances in which they may be useful.

05 VLOOKUP / HLOOKUP
- Wrong column/row can be referenced if new columns or rows are inserted.
- Inflexible - cannot look left and cannot be used between sheets.
- Other appropriate alternatives are available.

06 Complex formula
- Difficult for a model user or reviewer to understand and edit.
- Significantly increases the risk that the formula contains an error.

**Note, ‘complex formula’ can take many forms (long formula, poor syntax, complicated functions, etc.). A common rule of thumb is any formula with 3 or more parenthesis should be considered complex.

07 {Array functions}
- They are complex and hard for most model users to understand and amend.
- If formula is edited and Ctrl + Shift + Enter is not used, formula will return the wrong value.
- Multi-cell array functions are difficult to control when making changes to worksheet structure (e.g. insert or delete rows / columns).

08 Nested IF statements
- Very hard for anyone to understand logic.
- Very risky when editing and difficult to check whether all branches of the formula work as intended.

09 Pivot tables
- Don’t refresh automatically so if the source data is updated, they must be updated manually.
- Calculations in Pivot Tables are opaque.
- Significantly increases the file size.

Dynamic named ranges
- Not transparent to model users and difficult to understand and amend.
- Difficult to identify (only accessible via the Name Manager).
- A change in model structure can inadvertently create an error.

11 Merged cells
- Introduces risks if used with formulas; may not copy across as expected.
- Makes it more difficult to select individual rows or columns and to cut / copy / paste cells.

05 VLOOKUP / HLOOKUP

Lower risk

- Risky if used incorrectly, but can be safely deployed if all developers and users understand and mitigate the risks.

12 XNPV / NPV / IRR
- All of these functions need to be used very carefully to ensure they get the intended results, as they use simplified and often imprecise assumptions.
- The IRR sometimes produces inaccurate results.
- An approach applying first principles may be more appropriate.

13 Avoidable VBA code
- Greatly reduces transparency and requires specialist skills to maintain the model.
- Very difficult to ensure VBA code will work in all circumstances.
- Difficult for most people to review.

14 ROUND, ROUNDUP, ROUNDDOWN
- May inadvertently hide mistakes particularly when used on error checks.
- If rounding is implemented too early in a string of logic, it could cause the results at the end of the logic string to be inaccurate.

15 ISERROR, ISERR, IFERROR
- Excel Error messages are useful and have a purpose – to notify you of errors!
- These functions hide a wide range of error messages, some of which you may need to see in order to know that something has gone wrong.
- Always test for the specific error (e.g. ISNA).

16 External links
- Easy for error to occur if rows or columns are inserted in either the source or destination file without a corresponding change in the other file.
- Need to ensure that the links are always referring to the right file, particularly if the file name changes or the file moves.
These Modeling Guidelines exist to assist ensure a high and consistent level of quality across every model produced. These Modeling Guidelines are considered to be universal for all models. Note exceptions to these Guidelines may be justified in certain circumstances; such as, for output and dashboard sheets where the Modeling Guidelines conflict with the visual requirements of these sheets.
Modeling Guidelines

01 Model Settings

Include general model settings on an inputs sheet

The following model characteristics provides important context for all users:

2) General model settings

<table>
<thead>
<tr>
<th>Model name</th>
<th>Project ABC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model owner(s)</td>
<td>Ryan Nicholas</td>
</tr>
<tr>
<td>Model status (e.g. draft, final)</td>
<td>Final</td>
</tr>
<tr>
<td>Model start date</td>
<td>January 1, 2016</td>
</tr>
<tr>
<td>Model end date</td>
<td>December 31, 2025</td>
</tr>
<tr>
<td>Number total periods</td>
<td>10</td>
</tr>
<tr>
<td>Number of actual periods</td>
<td>2</td>
</tr>
</tbody>
</table>

Display general model settings on the cover sheet

Typically the cover sheet is the first worksheet within the model.

Displaying general model settings reiterates the importance of these settings and helps communicate them clearly.

02 Workbook Structure

Maintain distinct sheet types

Distinct worksheets assist users orientate through the model; examples of such worksheets include:

- Cover sheet (which may contain: model overview, notes and table of contents, navigation)
- Inputs sheet(s)
- Calculations sheet(s)
- Outputs sheet(s)
- Review sheet (contains independent review steps, notes and a sign-off for each Section).

Table of contents for each sheet and, potentially, each section provides useful context

A table of contents for workbooks with several sheets outlines the structure and composition of the underlying workbook.

This provides a summary of the model as well as navigation.

Hyperlinks can be applied to table of contents to facilitate easy navigation

Hyperlinks create efficient navigation. Including a hyperlink back to the table of contents ensures any sheet can be accessed within two clicks.
Worksheet Structure

Maintain key items in the same location

Ensuring key information (such as: title, sub-title, navigation, and error checks) is located in the same location provides consistency and aids with comprehension.

Maintain columns with clear and consistent purposes

Examples include columns for the following purposes: headers, descriptions, units, comments, sources, error checks, sense checks, totals and time series.

Maintain consistent column widths and labels for inputs and calculations of the same periodicity

The intent is to maintain column widths and labels consistency across all input, calculation and output sheets where possible.
### 03 Worksheet Structure (cont.)

**Divide sheets into ‘sections’ using clearly formatted section headings**

Create an organized workbook by using consistent formatting for section headings that are appropriately ordered to clearly distinguish differences.

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Revenue</td>
<td>Product A revenue</td>
<td>$m</td>
</tr>
<tr>
<td></td>
<td>Product B revenue</td>
<td>$m</td>
</tr>
<tr>
<td></td>
<td>Total revenue</td>
<td>$m</td>
</tr>
<tr>
<td>2) COGS</td>
<td>Product A COGS</td>
<td>$m</td>
</tr>
<tr>
<td></td>
<td>Product B COGS</td>
<td>$m</td>
</tr>
<tr>
<td></td>
<td>Total COGS</td>
<td>$m</td>
</tr>
</tbody>
</table>

**Use cell and sheet protection to control access to cells that are to remain consistent**

This reduces the likelihood of accidental errors and encourages users to only change input cells.

**Apply sheet tab coloring to differentiate inputs, calculations and outputs**

Colors help model users to quickly identify the purpose of each worksheet. Use a consistent color for each sheet type.

Different types of outputs to have different colors.

### 04 Cell Formats

**Format in accordance with a formatting key**

A formatting key helps provide context over different values within the model (as an example, the difference between all links and inputs from external workbooks vs internal sources).

An example of format key is as follows. Note changes and additions to these defined formats may be required to meet client or model demands.

- **Format key**
- **User input**
- **Link in from external workbook / source**
- **Notification**
- **Formula (100% formula)**
- **Text (100% text and text that includes formula)**
- **Link in from different worksheet**
- **Hyperlink (navigation)**
- **Work in progress / incomplete**
- **Error Check**

**Display the format key prominently in the model**

Display the format key in a prominent location (such as cover sheet) to make it easier for users.

**Enter inputs once (on an inputs sheet) in the model**

Having the same input entered more than once necessitates that multiple edits are required as assumptions change. Rather, use a link to the source input cell. Try not to daisy-chain (i.e. link to other links, rather than linking to the source).
Enter a heading or name (hardcoded text) in the model once

Repeated headings or names can be linked to one source.

Limited choice or binary inputs can use in cell list boxes (i.e. data validation and list)

Allows for binary, limited or multiple choices without cell links.

Maintain ‘List’ inputs in a dedicated ‘lists’ section on an inputs sheet

A named range can be utilized to ensure ‘Lists’ are consistent in the naming convention and description.

Ensuring ‘Lists’ are maintained can assist ensure all unique combinations are captured.

Bracket negative numbers

Bracketing negative numbers easily differentiates between ‘inflows’ and ‘outflows’.

| Negative numbers | $m | 50 | 50 | (50) | 50 |

Format zeros as dashes

This allows 0s to be visually distinct from 1s in flags.

| Formatting zeros | 1 / - | 1 | - | 1 | 1 |

Formatted numbers appropriately (e.g. %, x) and have a units column

Applying consistent number formatting ensures uniformity and helps avoid and identify calculation issues.

Consistently align all numbers across rows and down columns

Alignment assists with analysis and checking as anomalies (such as large vs small, positive vs negative values, etc.) stand out more readily when aligned and are easily comparable. Different alignment may be applied to numerical values (e.g. percentages, currency, units) vs text.

Not all formatting guidelines are applicable on output sheets

Output sheets must visually meet stakeholder requirements and can deviate from the formatting in the rest of the model in order to tell the story.
05 Time Series Labels

Maintain consistent time series labels in the same location for sheets with similar time series content

Maintaining consistent labels (such as header, period start date, period end date, period type (e.g. actual, forecast) and period number) in the same location ensures uniformity.

Link time series as a calculation to the labels on the relevant inputs sheet

Labels on all other sheets can be direct links to the inputs sheet.

Utilizing ‘named ranges’ may be effective in applying consistent time series information and cell location.

Calculate time series labels on the inputs sheet using general model settings

Once initially calculated, all instances of that same time series throughout the model can be pulled from that initial calculation, time series calculations flow throughout the model.

Calculate time series flags or counters in one place in the model where practical

Timing flags serve multiple purposes: indication for the timing of events, toggling cells on/off, and dynamic updating without introducing complex formulas.

Adopt an approach of a single periodicity per worksheet (e.g. do not mix quarterly and annual on a single sheet)

This avoids the risk and complexity of multiple periodicities.

Create separate ‘input’, ‘output’ and / or ‘calculation’ worksheets if more than one periodicity is used.

Summary columns to the left of the main time series are permitted.

Use consistent calculations when summarizing Monthly / Quarterly to Annual

This assists with error identification as inconsistent values are easier to spot.

Subtotals, as opposed to SUMIF on the subtotal, can be more robust.

Use checks to compare Annual subtotals to Monthly / Quarterly subtotals.

Calculate time series labels on the inputs sheet using general model settings

Once initially calculated, all instances of that same time series throughout the model can be pulled from that initial calculation, time series calculations flow throughout the model.

Do not daisy chain
**Modeling Guidelines**

### 06 Formulas

#### Construct formulas so they are consistent across columns

All formulas should be able to be copied across all columns.

\[
\begin{align*}
= E17 + F18 &= F17 + G18 = G17 + H18 = H17 + I18
\end{align*}
\]

#### Calculate formulas which are constant across time periods in the constants column

To distinguish constant values (i.e., those that do not change over a time series from those that do), maintain a column for constant values.

This visually distinguishes constant calculations from time series calculations.

#### Avoid cells that contain both a link to a different worksheet and a calculation

Instead, use conversion factors and flags with inter-sheet links or named ranges.

- **Wrong:**
  
  \[
  \begin{align*}
  \text{Revenue}$ m &= 300 = \text{Inputs'!K240} * \text{Inputs'!K241} \\
  \text{Price}$ &= 3.00 = \text{Inputs'!K240} \\
  \text{Quantity} &\text{ millions} = 100 = \text{Inputs'!K241} \\
  \text{Revenue}$ m &= 300 = \text{K99} * \text{K100} \\
  \text{Revenue}$ m &= 300 = \text{Price} * \text{Quantity}
  \end{align*}
  \]

- **Right:**
  
  \[
  \begin{align*}
  \text{Revenue}$ m &= 300 = \text{Price} * \text{Quantity}
  \end{align*}
  \]

#### Avoid repeating identical calculations in separate cells

Instead, link subsequent identical calculations to the original formula.

#### As a default, set workbooks to calculate ‘automatically’ (not ‘manually’) and not enable iterative calculations

This is a workbook level setting based on the first workbook open.

![Calculation options](image)

**Avoid circular references**

Circular references introduce risk into the model which could result in multiple possible outputs.

Circular references are used to calculate inputs, but are often assumed to be necessary parts of the model’s calculations.

There is almost no commercial situation where a circular reference is required.
Avoid hardwired inputs

Separate and label inputs on the input sheets and then link to other formulas.

Some exceptions include: 1, 0, -1 (and occasionally 12 and 4).

Break down complex formula into separate cells / rows

When formulas are complex, either break the formulas down into simpler formulas in separate cells/rows or incorporate logic diagrams of the formulas.

= $R8 * (S$2 >= $R9) * (S$2 <= $R10)
= R17 * (1 + $R16)
= $17 * $R21
= $11 * $22

Flow calculations from left to right across columns and across sheets in the workbook. However, summary sections may be placed at the top of a sheet

This formatting style ensures consistency and efficiency in the calculations.

Avoid any references to blank cells

Use the ‘notification’ format and insert zeros to ensure this criteria is met.

For example, when referring to opening balances in \( t = -1 \) (i.e. opening balance for the first period).

Clearly define each row with a descriptive label

Ensure that all labels adequately describe the row’s content.

<table>
<thead>
<tr>
<th>Summary</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue - Product A</td>
<td>$m</td>
</tr>
<tr>
<td>Revenue - Product B</td>
<td>$m</td>
</tr>
<tr>
<td>Revenue - total</td>
<td>$m</td>
</tr>
<tr>
<td>Cost of goods sold - Product A</td>
<td>$m</td>
</tr>
<tr>
<td>Cost of goods sold - Product B</td>
<td>$m</td>
</tr>
<tr>
<td>Cost of goods sold - total</td>
<td>$m</td>
</tr>
</tbody>
</table>

Include a text label beside a named range

This ensures that all named ranges are easily identifiable.

A common best practice is to differentiate with different formatting (such as smaller font size & italics).
Include a dedicated section in each workbook for sense checks

The sense checks section consolidates all sense checks from every sheet in the model.

Sense checks are for ‘rules of thumb’ that indicate model values are outside normal parameters (e.g., revenue growth is above X%) or financial/contractual checks that don’t necessarily indicate model error (e.g., covenant tests and negative cash balances).

Link overall error and sense check results to the sheet sub-title on every sheet

Link the sheet sub-title and to display the result of any error checks.

Use conditional formatting to show when error & sense checks are triggered

Conditional formatting serves as an alarm for the builder(s) and user(s). Use a distinct cell color to indicate triggered error checks and sense checks.

Include a column in each worksheet to sum up error checks in every applicable row

It’s best practice to include error checks wherever possible. This allows quick identification of the source of any issue triggered.

Each error check row can be summarized in a designated column.

Include a cell in the freeze panes across each worksheet that summarizes the error checks in the worksheet

Maintain a total error check in the same location of every worksheet.

Model users may decide to show: the number of distinct errors; a binary indication whether there is an error or not in the worksheet; or the actual magnitude (differences) in error.

Maintain a dedicated section in the workbook to summarize all error checks

The error checks section consolidates all error checks from every worksheet in the model.

Error checks are for logical/mathematical issues that must be errors (e.g., the balance sheet not balancing).
07 Checks (cont.)

*Format header sheets to change when an error is triggered*

Use a distinct cell color to indicate triggered error checks and sense checks.

*Make use of the ABS function for error checks*

This function simplifies the error check by converting negative to positive values.

\[
= \text{ABS}(1 - \text{SUM}(T57:T58)) > \text{ErrorTolerance}
\]

Ensures check is positive

Changes TRUE/FALSE to 1/0

Named Range: Allows for Excel calculation engine inaccuracy

08 Comments & Sources

*Allow for Comments | Sources | Responsibility columns in input sheets*

The location of these columns may vary depending upon specific model requirements.

<table>
<thead>
<tr>
<th>Comments</th>
<th>Sources</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-month forward LIBOR curve</td>
<td>Bloomberg (15-January 2018, 12:00 EST)</td>
<td>Ryan Nicholas</td>
</tr>
<tr>
<td>Sourced from term sheet</td>
<td>Project ABC - senior secured note.pdf</td>
<td>Jane Smith</td>
</tr>
</tbody>
</table>

*Comments | Source | Responsibility columns on the inputs sheet explain input sources*

Input source comments could include a hyperlink to the source.

*Include notes describing the workbook and its overall content in a cover sheet*

The notes can describe the purpose of the model, the intended users, any assumed knowledge and highlight any unusual or complex sections.
External links

Separate links external to workbooks through the use of a dedicated inputs section/sheet

In order to reduce the risk inherent in the model, it is important to centralize and identify all external workbook links.

If there are many links to multiple external workbooks, centralize their location (such as dedicated input sheet(s))

Organize links to an external workbook with a consistent layout.

Where external workbook links are used, recalculate the subtotals and use error checks to ensure that the source and destination locations remain consistent

Error checks test that changes to the source file are picked up.

Ensure that time series labels are consistent with labels in any linked external workbook

This ensures consistency between workbooks.

Printing & Viewing

Maintain the same print zoom percentage for every sheet

As a general rule, an 85% page view (zoom) may be appropriate.

Set worksheets view to Normal not Page Break Preview.

Cell A1 can serve as the active cell of each sheet before finalizing the workbook

The cell that is active when the workbook is saved is what the users will first see when they open the workbook. Consider saving accordingly (e.g. the cover sheet, instruction sheet, inputs/assumptions, disclaimer, etc).

Use ‘freeze panes’ to keep the titles and times series labels in view

Utilize freeze panes to keep important labels in constant view including row headers, titles, column descriptions and checks.

Apply freeze panes to worksheets where a time series label is applied.

Model builders may also utilize ‘split’ view, however this is only suggested if multiple view panes with separate sections are going to be utilized.

Frozen panes section

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Error</th>
<th>Sense</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: External Workbook 1 inputs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantity - Product A</td>
<td>100</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Quantity - Product B</td>
<td>100</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Total Quantity (calc)</td>
<td>200</td>
<td>150</td>
<td>300</td>
</tr>
<tr>
<td>Total Quantity (source) check - external source data</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ensure that time series labels are consistent with labels in any linked external workbook

This ensures consistency between workbooks.
Set and scale the print view appropriately

This ensures the sheets will print as intended.

The print scaling should generally be set to the same percentage for every sheet

This ensures that print scaling is consistent across worksheets with the same time series.

Use Rows and Columns to repeat (where practical) to print titles and time series labels on every page

This ensures that titles and time series labels are printed on every page.

Footers can include important information (such as: file name, date printed and page numbers)

This ensures that printed copies can be related to a file and time.

Avoid hiding rows or columns. If necessary, Group and collapse

This ensures that hidden rows or columns are identifiable.

Complete a review before finalizing

Document the review process.

Document review steps for every section and sheet in the workbook

Be systematic and consistent in review procedures.

Include a mixture of review processes to review inputs, formulas and outputs in the workbook

As part of review steps, examine adherence to Modeling Guidelines.

Conduct review steps with a qualified individual who is not the model builder

Model builders cannot always find their own errors. Model builders should not build the model and be the sole reviewer of the model.
Other

Only include VBA Macros within a workbook that are absolutely necessary

If included in the workbook, VBA Macros should be clearly notated and tested.

Avoid the use of VBA Macros created solely by using the ‘macro recorder’

The macro recorder introduces risk into the model because it does not produce reliable macros.

Separate sensitivity analysis inputs (if any) from the inputs

Separate sensitivity analysis inputs from the original inputs.

Apply a consistent file naming convention allowing for identification, status and version

Examples include: [Model Name] - [STATUS] - [vYYYY-MM-DD HHMM] [initials], [Model Name] – vX.XX (where ‘vX’ signifies iteration of external release, and ‘XXX’ represents edits between external release), etc.

Project|Gold - DRAFT - v2016-09-10 1230 TOB.xlsb

Apply freeze panes so that row and column headings and labels are visible on every sheet

Heading and label visibility is set individually for each sheet.
These Modeling Considerations serve to build upon the Modeling Guidelines. The following 39 Considerations may be applied (where practical) in conjunction with the Modeling Guidelines to improve the design of financial models.

01 Workbook

**Include a description of every sheet (and section where relevant) in the workbook**

This provides a written summary of the Workbook.

**Avoid the use of chart sheets in a workbook (place charts on worksheets)**

Chart sheets can be unnecessary and reduce overall sheet consistency.

**Locate chart data in a dedicated chart data section**

Chart data should be centralized and clearly labelled.

**Complete workbook 'properties' before finalizing**

Workbook properties are attached to each workbook file.

**Identify, label and separate real versus nominal numbers (if relevant)**

This increases clarity and reduces scope for interpretation errors.
Modeling Considerations

02 Worksheet

Group and hide blank columns at the right of the sheet content

Leave one blank column after the time series. This blank column may contain named range labels.

This can be done on every sheet before finalizing a workbook.

Avoid mixing numbers with different units in the same row

This avoids the risk of denomination errors and ensures consistency.

Apply named ranges for list inputs

Use a consistent list prefix for named lists.

<table>
<thead>
<tr>
<th>List 1 - Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>List.YesNo</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>List 2 - Actual/Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual</td>
</tr>
<tr>
<td>Forecast</td>
</tr>
<tr>
<td>List.ActualForecast</td>
</tr>
</tbody>
</table>

Where the cell link of a hyperlink is not cell A1 of a worksheet, apply Named Ranges for their destinations.

This reduces the risk of broken hyperlinks.

Give careful consideration before using form controls (use data validation and lists instead)

Form controls float over cells and require link cells. Avoid using Active-X controls where possible.
Modeling Considerations

03 Formatting

Identify the last row of the content on each sheet

Use a section heading to identify the end of content.

Emphasize totals, sub-totals or other key outputs using consistent formats

Format using borders, bold font and italics. Use only a few formats and keep them consistent throughout in order to maintain an easily legible workbook.

<table>
<thead>
<tr>
<th>Assets</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current assets</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash balance</td>
<td>$m</td>
<td>502</td>
</tr>
<tr>
<td>Accounts receivable</td>
<td>$m</td>
<td>310</td>
</tr>
<tr>
<td>Inventory</td>
<td>$m</td>
<td>407</td>
</tr>
<tr>
<td>Current assets</td>
<td>$m</td>
<td>1,219</td>
</tr>
<tr>
<td><strong>Non-current assets</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant and equipment</td>
<td>$m</td>
<td>988</td>
</tr>
<tr>
<td>Tax asset</td>
<td>$m</td>
<td>73</td>
</tr>
<tr>
<td>Non-current assets</td>
<td>$m</td>
<td>1,061</td>
</tr>
<tr>
<td><strong>Total assets</strong></td>
<td>$m</td>
<td>2,280</td>
</tr>
</tbody>
</table>

Ensure cell content is in view

Avoid cell sizes that cause any content to fall out of view. This also encourages the model builder(s) to consider when there is too much content in one cell, column or row.

Limit the use of font type except on output sheets

Changes in font stand out and inadvertently draw attention or cause concern.

Maintain the same font size for the numbers in the model except on output sheets

Changes in font and font size stand out and inadvertently draw attention or cause concern.

Note and highlight anything unusual or complex in a model

Use the Comments | Sources column to note these complexities.

Avoid merge cells in a workbook (unless required for chart formatting)

Merged cells can increase the risk of errors. Center Across Selection is an excellent alternative.
Use spaces in formula construction to make formulas easier to read (particularly longer or more complex formulas)

This increases the clarity of formulas and increases userfriendliness.

\[(S34 \times (A27 + B25)) / C28\]

Do not overuse brackets in formula

Excessive brackets make a formula more difficult to understand.

But do use them to make algebra clearer i.e. \(a - (b - c)\)

Adopt an approach where formulas can be easily explained (should take less than 30 seconds)

If formulas are difficult to explain, break complex formulas into separate components (cells).


Avoid the use of array formulas (unless no alternative)

Array formulas are overly complex and cause efficiency problems.

They are also difficult to review.

Use Go To > Special > Current array to identify the size of an array in order to edit it.

Ensure sign switches are conspicuous and clear to any model users

Use \(= 0 - \) which is easier for the user to see than \(= -\).

\[\begin{array}{cc}
\checkmark & \times \\
0 - A1 & -A1 \\
\end{array}\]

Row anchor all links to a different sheet

This creates links that are capable of being copied elsewhere on the sheet.

\[= \text{Inputs}'!E$44 \quad = \text{Inputs}'!F$44 \quad = \text{Inputs}'!G$44 \quad = \text{Inputs}'!H$44\]

Avoid including current worksheet references in formulas

This is unnecessary and confusing for model users.

\[\begin{array}{cccc}
\checkmark & = E44 & F44 & G44 & H44 \\
\times & = \text{Tax}'!E$44 & \text{Tax}'!F$44 & \text{Tax}'!G$44 & \text{Tax}'!H$44 \\
\end{array}\]

Avoid creating strings of links to links (daisy-chaining)

Link to original sources, the first formula.
Modeling Considerations

04 Formulas (cont.)

Resolve formula errors in outputs cell (even when inputs are varied)

Formula errors flow through to dependent formulas.

Error cells severely negatively impact on a user’s perception of a model.

Build formula (or formula blocks) such that they can be copied where identical logic is applied

Consistent formula blocks reduce risk and increase efficiency.

Used for repeating items such as: business units, debt tranches, revenue and categories.

Use and separate timing flags and indexation factors

Separate the ‘what’ from the ‘when’ to avoid complexity. See below as an example, the different periods (the ‘when’) have been distinguished from the timeline (the ‘what’).

<table>
<thead>
<tr>
<th>Flag Actual</th>
<th>1</th>
<th>-</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flag Forecast</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

05 Input

Avoid input cells in output sheets, unless they relate to output controls

For example, inputs for chart display or time period choices might be included on an output sheet (e.g. dashboard).

Data validation can be used on relevant input cells to provide guidance and/or limit inputs

Data Validation allows for comprehensive control over input cells.

Hyperlinks and symbols can be linked to a ‘show | hide’ choice on the inputs sheet

This allows for hiding hyperlinks for printing and viewing.

Adopt a consistent convention for inputting values (and label accordingly)

Adopt a consistent approach for adding inputs (such as: all inputs made as a positive, all credits positive & all debits negative, etc.) to avoid any confusion.

Enter data from external sources as static input values (where possible)

This removes the risk and complexity of external links.
Accompany a model with a ‘user guide’ or instructions that explains how to use the model

User guides should be as comprehensive and informative as possible.

Provide a model structure diagram with hyperlinks within the model to give greater context

This aids user understanding of the model and navigation.

Where possible, review steps should include reconciliation of key outputs to other sources

This should occur whenever there is another information source.

Avoid workbooks that require add-ins or additional software to operate or modify

Assume that users only have Microsoft Excel.

Ensure non-trivial models whose outputs are relied upon, are subject to an independent integrity review and often a professional model audit

This is an independent sign-off that the workbook content is correct.
The best financial models take a complex problem and break it down into a

simple, logical, easy to follow framework.

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We design and build best practice models that are low risk, flexible, user friendly and fit for purpose...

...and leverage them to create insightful analytics to support making better decisions

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