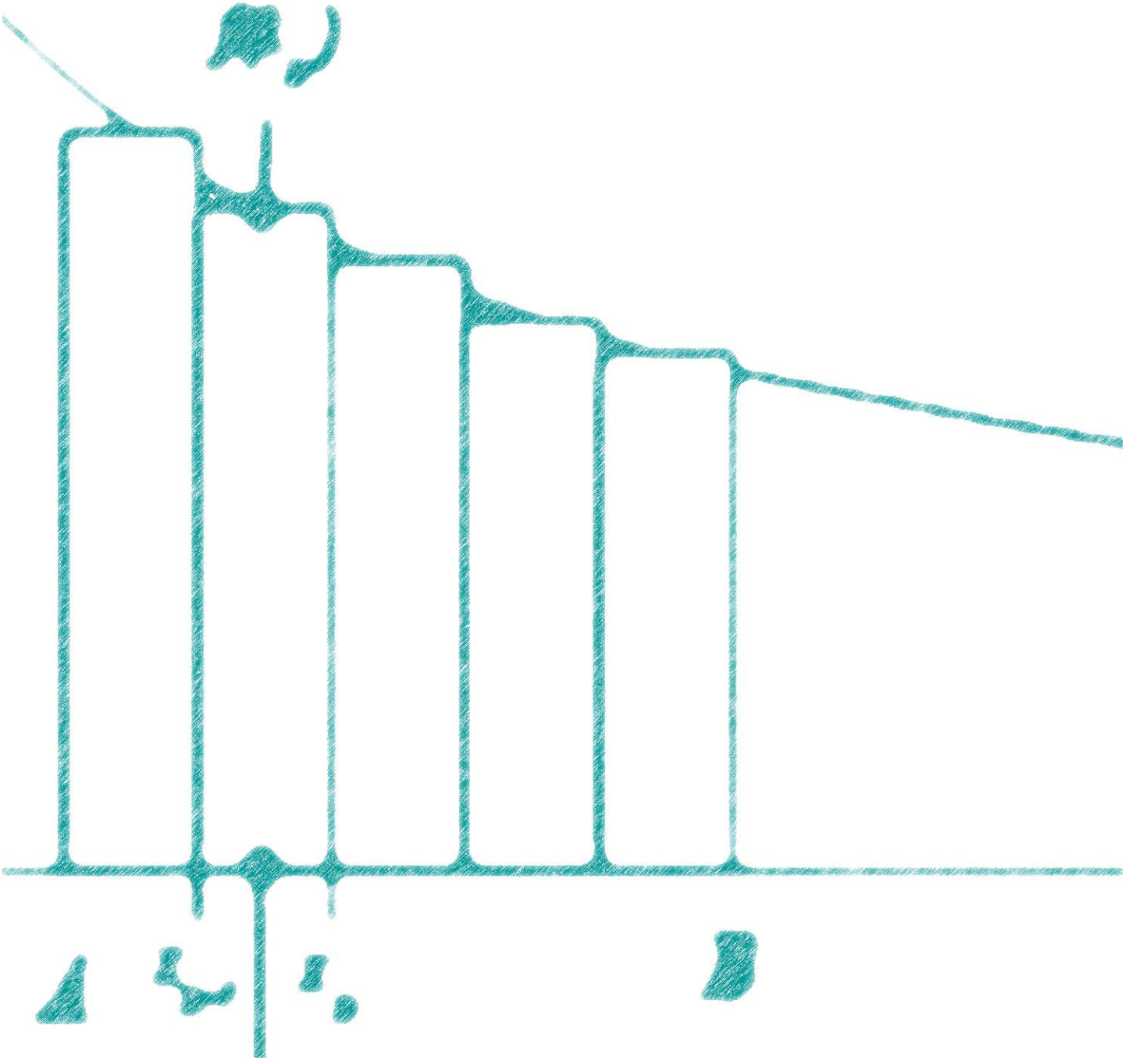
Technomics
The Science of Informed Decision Making

Midpoint Calculator

User Manual



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The Technomics Midpoint Calculator is designed to be a practical day-to-day learning curve analysis tool as well as a midpoint theory learning tool. The practical tool quickly calculates the midpoint of a lot and inserts either the answer or the formula directly into the spreadsheet. The theoretical learning tool provides a derivation and formulation of various midpoint formulas along with explanations of how each formula compares and contrasts to other midpoint formulas.

This manual provides an introduction to the Midpoint Calculator, its use, and tips and tricks on comparing and contrasting different midpoint formulas.

1 GETTING STARTED

Installing and starting the Midpoint Calculator

The Midpoint Calculator is a Microsoft Excel Add-In designed for use with Excel 2000 and 2003. To install the add-in, first save the *xla* file to your hard drive. Under Excel's Tools menu, select *Add-Ins…*, browse to the saved *xla* file, and place a checkmark next to "*Midpoint Calculator*." Click *OK* and the Midpoint Calculator will install.

If the installation is successful, the Midpoint Calculator will be accessible from Excel's *Tools* menu (see Figure 1).

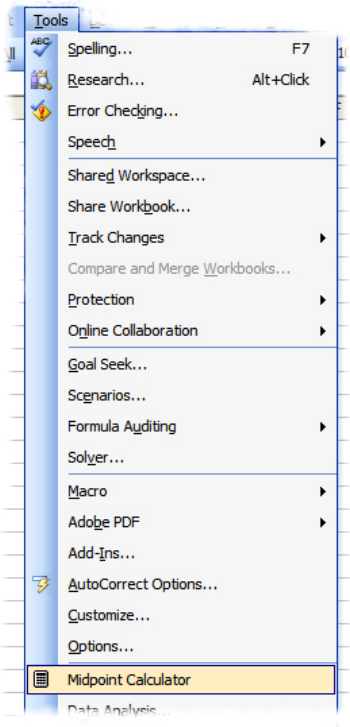


Figure 1. Midpoint Calculator in Excel's "Tools" menu.

To uninstall the calculator, select *Add-Ins…*, uncheck "Midpoint

Calculator," and click *OK*. The Midpoint Calculator will uninstall and remove itself from Excel's *Tools* menu.

2 INTERFACE OVERVIEW

The Midpoint Calculator's interface on start-up is given below in Figure 2. This initial condensed view shows the *Formula List*, the *Formula Description*, and the *Formula Text Box*.

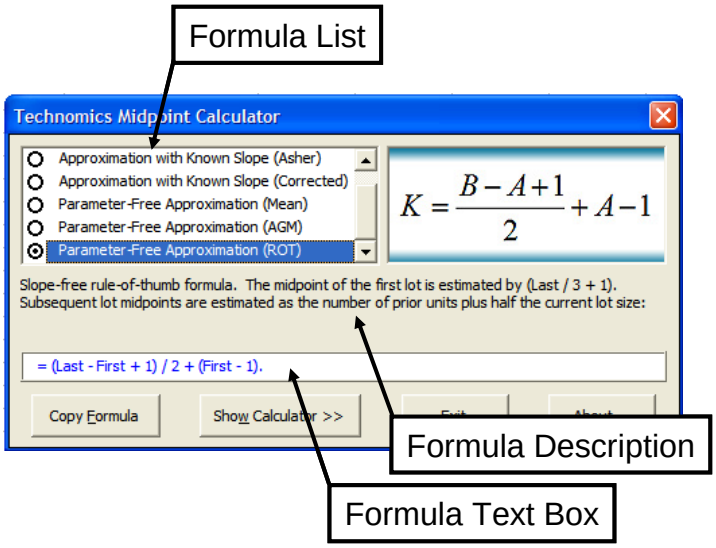


Figure 2. Condensed interface of the calculator.

Clicking on *Show Calculator* expands the form to show the calculator inputs, outputs, and insertion options for the selected midpoint formulas (Figure 3).

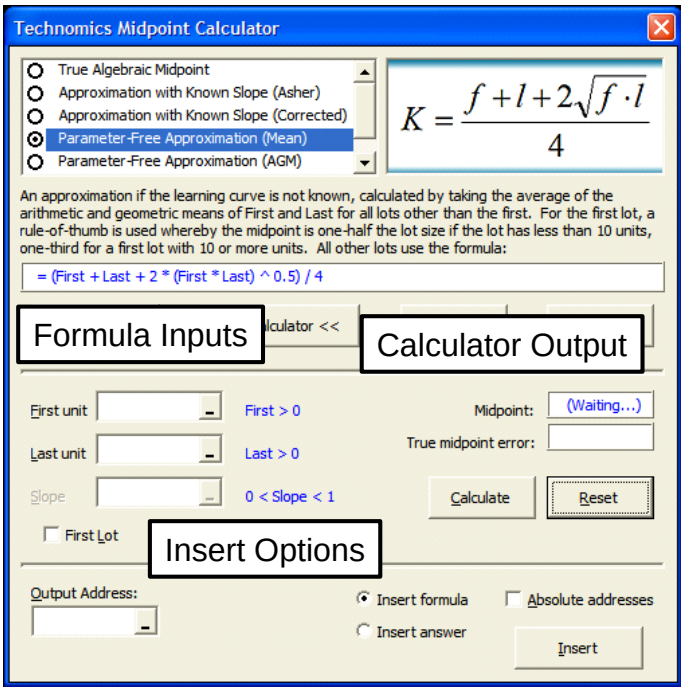


Figure 3. Expanded interface of the calculator.

The main interface consists of the following buttons and options.

Formula Selection Options

FORMULA SELECTION

Formula List: Contains the list of all available midpoint formulas for use in the calculator. Use the scrollbar to view the complete list. To activate a formula, click the formula's name in the list. An image of the selected equation will appear to the right of the list.

Formula Description: Provides a brief description of the selected midpoint formula and its required inputs. For more detailed explanation on the derivation and theory behind each formula, please see Appendix I.

Formula Text Box: Provides a text version of the selected midpoint formula. In most cases, the formula in the *Formula Text Box* is a text string that Excel will recognize and evaluate as a valid formula, provided the variables *Last, First*, and *b* are replaced with valid numbers. In other cases, it is not possible to create a single equation for the midpoint formula that can be evaluated in Excel. In these latter cases, a more general, descriptive formula is given in the *Formula Text Box*.

For Example, selecting "Parameter Free Approximation (ROT)" in the *Formula List* will present

```
= (Last - First + 1) / 2 + (First - 1)
```

Equations beginning with an equal sign "=" in the Formula Text Box can be directly evaluated by Excel.

in the *Formula Text Box*. If this formula text is copied and pasted directly into an Excel spreadsheet, the formula will be evaluated by Excel. The formula will yield a `#NAME?` error unless *First* and *Last* are replaced by numbers or are previously defined names. However, if "Approximation with Known Slope (Corrected)" is selected in the *Formula List*, the following appears in the *Formula Text Box*:

```
((Last - First + 1) ^ -1 * [Approximated Sum +
Correction Terms]) ^ (1 / b).
```

In this case, there is no single formula that can be inserted into an Excel spreadsheet to yield the answer. The answer is calculated using a Visual Basic for Applications (VBA) routine, and thus cannot be represented within an Excel cell.

Copy Formula Button: Copies the text string in the *Formula Text Box* to the Windows Clipboard.

Show Calculator Button: Expands the interface to reveal the inputs, output, and spreadsheet insertion options for the selected midpoint formula.

Exit Button: Hides the calculator. The calculator is cleared from memory when exiting Excel.

About Button: Provides copyright, distribution rights, and additional information about the calculator.

Formula Input Options

FORMULA INPUTS

First Unit, Last Unit, Slope: Range input boxes for inputting the cell addresses of the first unit, last unit, and the slope (if required).

First Lot Checkbox: Indicates whether or not the calculator should calculate the midpoint as a first lot midpoint. Some formulas calculate first lot midpoints differently than subsequent lot

midpoints. If this option is available then the selected formula has a different method for calculating first lot midpoints. If this option is not available then the selected formula calculates all midpoints the same regardless of lot number.

Calculation Options

CALCULATION OPTIONS

Calculate Button: Updates the calculator output.

Reset Button: Clears all formula inputs, output, and insertion options.

Midpoint Text Box: Provides the calculated midpoint answer.

True Midpoint Error Text Box: Provides the error associated with the calculated midpoint answer. If possible, the calculator will compare the selected midpoint estimate with the true algebraic midpoint.

Formula Output Options

OUTPUT OPTIONS

Output Address: Accepts a cell address to output either the calculated answer or the selected midpoint formula.

Insert Answer Option: When selected, the calculator will insert the calculated midpoint answer into the cell address provided in the *Output Address* box.

Insert Formula Option: When selected, the calculator will insert the selected formula into the cell address provided in the *Output Address* box. By default, the formula will reference the addresses provided in the *First Unit*, *Last Unit*, and *Slope* boxes. If valid addresses are not provided in the *First Unit*, *Last Unit*, or *Slope* boxes, then the required inputs of the inserted formula are replaced with text variables. Note that this option is only available for midpoint formulas that can be represented within spreadsheet cells using inherent Excel functions—it is not available for midpoint estimates that require calculation through VBA routines.

Absolute Address Checkbox: When checked, this replaces any relative addresses provided for *First Unit*, *Last Unit*, and *Slope* with

absolute (or anchored) addresses.

Insert Button: Inserts either the calculated answer or the complete formula into an Excel spreadsheet according to the selected output options.

3 USING THE CALCULATOR

Using the Midpoint Calculator simply requires selecting the desired equation from the *Formula List*, inputting the first unit, last unit, and slope if necessary, and clicking *Calculate*.

Selecting the Formula

To select the desired midpoint formula, scroll through the Formula List and click on the formula you wish to use. The equation will appear to the right of the *Formula List*, and a short description of the formula will appear below the list.

The Formula Text Box

The *Formula Text Box* provides a text version of the selected formula. If the formula in the *Formula Text Box* begins with an equal sign ("="), then the formula may be copied and pasted directly into an Excel spreadsheet cell. In order for Excel to properly evaluate the formula, the variables *First*, *Last*, and *b* need to be replaced with either valid cell addresses or the appropriate values. A `#NAME?` error will occur if the *First*, *Last*, or *b* variables are not defined as numbers, cell addresses, or named ranges.

Clicking *Copy Formula* will copy the text in the *Formula Text Box* to the Windows Clipboard.

Note: The single cell formula used to evaluate the True Algebraic Midpoint is an **Excel array formula**. In order for an array formula to evaluate correctly, the numbers in the series must be fully enumerated in contiguous cells between the first unit and the last unit. In other words, the number of cells being evaluated by the formula must equal the number of units in the lot, and they should all be in the same row or column. If the array formula operates on the incorrect number of cells, the formula will return an incorrect answer. If you are not familiar with Excel array formulas, please refer to the example in the Appendix for more information.

Providing Inputs

In order to calculate the midpoint, you will need to provide the first unit of the lot, the last unit of the lot, and, depending on the requested formula, the slope of the learning curve.

First, display the input, output, and insertion options of the calculator by clicking *Show Calculator*. The *First Unit*, *Last Unit*, and *Slope* input boxes accept valid cell ranges from the active workbook. To enter an address, activate the input box and either type in the cell address or click on the desired cell within the spreadsheet. The cell address must refer to one cell only. To enter a named range, simply type the name in the address input box.

Calculating the Midpoint

Once the inputs have been entered, click *Calculate* to evaluate the selected formula. The midpoint answer will appear in the box to the right of the *Calculate* button.

Before evaluating the midpoint formula, the calculator will validate the inputs and will provide feedback if any inputs are not acceptable. The following error messages may appear near the *First Unit*, *Last Unit*, and *Slope* address input boxes if a valid number or address is not entered:

Input Error	Reason
Value?	The input box requires a cell address. If an address is provided, then the referenced cell is either empty or does not contain a valid number.
Range?	The cell address or named range is not valid.
Cell?	The range refers to more than one cell.
(Div by zero)	The midpoint formula cannot be evaluated if the slope parameter is equal to 1.

The following error messages may appear in the calculation output box if an input is not valid:

Calculation Error	Reason
First = 0 ?	First unit number cannot be zero.
Last = 0 ?	Last unit number cannot be zero.
First < 0 ?	First unit number must be greater than zero.
Last < 0 ?	Last unit number must be greater than zero.
First > Last ?	First unit number must be less than last unit number.
First = Last ?	First unit number must be less than last unit number.
First < > 1 ?	Occurs if the First Lot checkbox is checked but the first unit number is not 1.
Slope > 100% ?	Slope must be less than 100%.
Slope < 0% ?	Slope must be greater than 0%.
Slope = 0% ?	Slope cannot be 0%.
Asher 50% ?	Slope cannot be equal to 50% when evaluating the Asher and corrected Asher formulas.

Asher True Midpoint Error

When the Asher or corrected Asher approximations are selected, a *True Midpoint Error* calculation will appear below the midpoint answer (Figure 4).

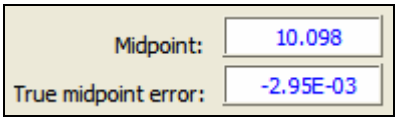


Figure 4. True midpoint error output.

The true midpoint error is the error of the current midpoint estimate relative to the true algebraic midpoint, or

$$Error = \frac{Estimated\ Midpoint - Algebraic\ Midpoint}{Algebraic\ Midpoint}.$$

In the example given in Figure 4, the estimated midpoint using Asher's approximation is 10.098, while the actual algebraic midpoint is 10.128. This leads to a relative error of -0.003.

First Lot Checkbox

The *First Lot* checkbox is enabled when either the Mean or Rule-of-Thumb parameter-free approximation has been selected. If checked, the calculator will use recommended alternative estimating equations to estimate the first lot midpoint. If left unchecked, the calculator will use the standard subsequent lot midpoint estimating equations.

For example, suppose the first unit is 1, the last unit is 25, and the slope is 99%. If the "Parameter-Free Approximation (ROT)" formula is selected, the midpoint is estimate as 12.5. This estimate is calculated using the standard rule-of-thumb equation, (Last - First + 1) / 2 + (First - 1). If *First Lot* is checked, the midpoint estimate is now calculated using the alternative first lot formula, (Last / 3 + 1), or 9.333. If the first unit is 2 or larger, the *First Lot* checkbox must be left unchecked.

The calculator returns an error if the *First Lot* option is checked and the first unit is not equal to 1.

4 CALCULATOR OUTPUT

The Midpoint Calculator is able to export the selected formula or midpoint estimate directly into the active worksheet. To export the answer or the formula, enter the target address in the *Output Address* input box. A cell address can be entered into the *Output Address* box by either selecting the target cell in the active worksheet, typing the cell address, or typing a valid named range that refers to a single cell. Once an address has been entered, select either the *Insert Answer* or *Insert Formula* option, and click *Insert*.

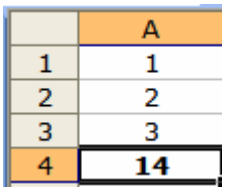
Insert Answer will insert the estimated midpoint into the cell specified in the *Output Address* box. *Insert Formula* will insert an Excel formula into the target output cell that references the input cells defined in the *First Unit*, *Last Unit*, and *Slope* address input boxes. If the *Absolute Addresses* checkbox is checked, the *Insert Formula* option will replace any relative addresses provided for *First Unit*, *Last Unit*, and *Slope* with absolute (or anchored) addresses. If any of the cell references required for the formula are missing or invalid, the required input will be replaced by a variable placeholder (*_FIRST*, *_LAST*, or *SLOPE%*).

Appendix

Using Excel Array Formulas to Calculate Midpoints

An array formula operates on an array, or series, of input numbers. They are typed into cells like normal formulas, except to enter them the user presses Ctrl + Shift + Enter.

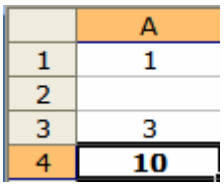
As an example, consider the following simple array formula example that sums the squares of the numbers in cells A1, A2, and A3.



	A
1	1
2	2
3	3
4	**14**

The formula in cell A4 is {=SUM(A1:A3^2)}. Notice that the formula's array argument spans cells A1 through A3, and all three of A1, A2, and A3 have numbers in the cells. This formula evaluates as $1^2 + 2^2 + 3^2 = 14$.

Now consider the next example:



	A
1	1
2	
3	3
4	**10**

The formula in cell A4 in the second example is still {=SUM(A1:A3^2)}. However, because cell A2 is empty, the formula is evaluated as $1^2 + 3^2 = 10$.

This notion is particularly important when evaluating formulas for midpoints that require summing operations on an array of lot numbers. In Example 3, the following array formula in cell A9 yields the total cost of a lot if the first unit is 1, the last unit is 8, the slope is 92% (b = -.1203), and T_1 is $10.

	A	B
1	1	**T1**
2	2	$10
3	3	
4	4	**b**
5	5	-0.1203
6	6	
7	7	
8	8	
9	**$68**	

The formula in cell A9 is {=B2*SUM(A1:A8^B5)}, and is evaluated as

$$\$10 * (1^{-0.1203} + 2^{-0.1203} + \ldots + 8^{-0.1203}) = \$68.$$

Compare Example 3 with the following Example 4. Example 4 appears at first to be the same or a similar formula, but notice it is evaluated entirely different by Excel because of the missing cells in between the first unit, 1, and the last unit, 8.

	A	B
1	1	**T1**
2	8	$10
3		
4		**b**
5		-0.1203
6		
7		
8		
9	**$18**	

The formula in cell A9 is {=B2*SUM(A1:A2^B5)}, and is evaluated as

$$\$10 * (1^{-0.1203} + 8^{-0.1203}) = \$18.$$

Remember, Excel will not assume that every number in the array between the first and last unit numbers is an integer that needs to be evaluated. Excel simply evaluates every cell in between the defined array parameters.