

1D vs 3D Analysis

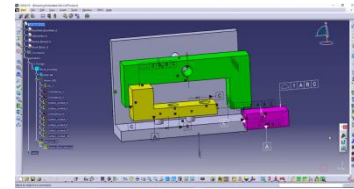
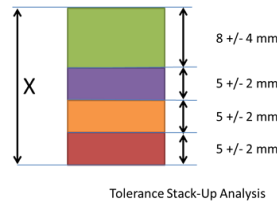
What 1D Excel Stacks are Missing

Here are 4 ways Excel is failing your tolerance analysis:

1. No 3D Influence

It is rare that all the parts in your product line up into a perfect linear line. Most often, there are parts arranged around your stack-up, and these part's tolerances will influence your linear stack. This 3 dimensional influence can cause more variation than you'd expect, and a 1D stack-up in Excel is not going to account for this.

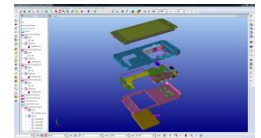
Even with a linear stack-up, you can have angularity that will cause additional variation, or variation and issues unaccounted for in your Excel stack. These 3 dimensional issues are related to the geometry of the parts, and require a CAD-based approach to properly simulate and validate.



Parts rarely line up in neat lines

2. Ignores Assembly Variation

An Excel stack assumes that all of the parts are assembled. Unfortunately, the presence of tooling, and the assembly process itself can add variation into a product. This isn't accounted for in Excel stacks, and requires a simulation of the assembly process itself, tooling and all. This can sound like an ambitious goal, but many tools on the market, like 3DCS Variation Analyst, offer tools to create virtual tooling, and assemble the product with CAD.

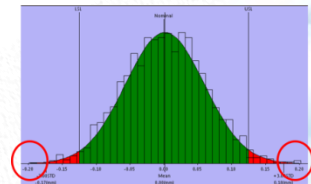


3. Only Worst Case - Statistically Unrealistic - designing to outliers

A 1D stack-up generally uses a single instance for Worst Case. Most utilize the maximum tolerance, the uppermost limit, when calculating the tolerance stack. This 1D Worst Case is the very largest possible outcome for the given measurement, whether it is a gap or flush or profile condition. This scenario has two important issues:

A. It isn't the True Worst Case - only max/min condition

B. It is statistically Improbable – less than 0.1% likelihood



4. Ignores Non-linear Relationships

As mentioned above under item 1, angularity and non-linearity in the stack-up can cause additional variation that can only be simulated with a 3D simulation. Non-linear relationships are difficult to simulate accurately, because in many cases the tolerances influence one another, changing their actual range from the specified range, effectively causing tolerances to act with a magnification. This could cause your +/- 1 mm tolerances to have an effective range of +/- 1.2 mm, which may sound like small change when discussing car door gaps, but can have enormous impact when you are looking at the internal components of a phone, or a Pacemaker.

