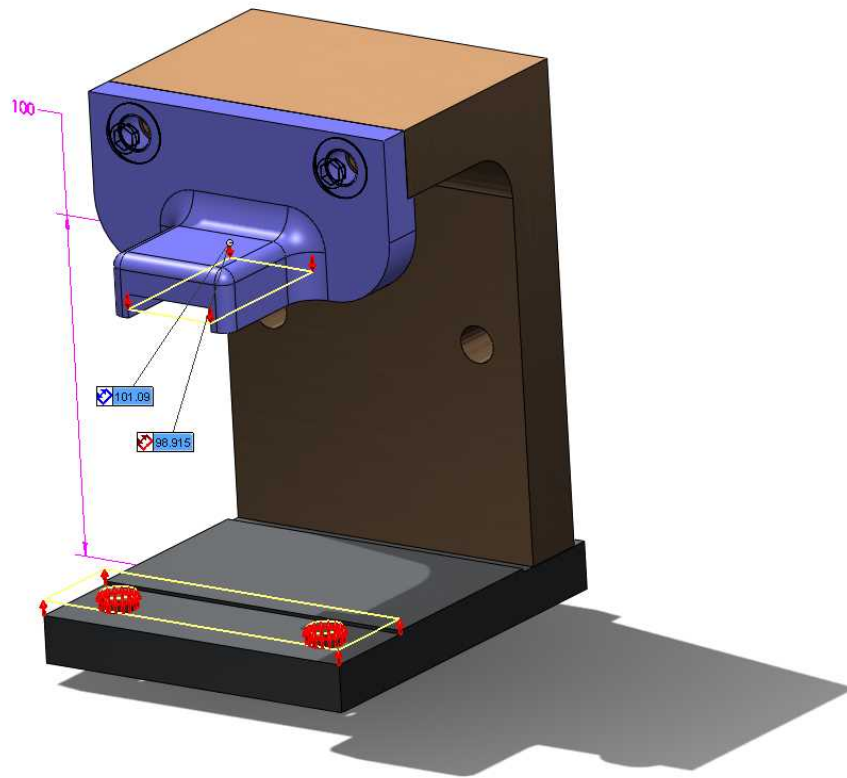# SolidWorks TolAnalyst
Frequently Asked Questions

Q: What is tolerance stack-up analysis?
A: A Tolerance Stack-Up Analysis is an analysis used by designers and engineers to determine if an assembly of parts will fit together and function properly. The analysis is based on the dimensioning scheme of the individual parts and how they are assembled.
Here's an easy way of looking at it: Assemblies are made up of parts. Every part contains dimensions to define the part. All dimensions have tolerances. Since it's actually impossible to manufacture a part perfectly to a given size, designers provide a tolerance, or a range of error that is acceptable for a particular feature in a part. What engineers worry about is what happens to the fit and function of their assembly when all those parts, with all those tolerances, get assembled together. Can they be sure that their assembly will fit together and function properly. This is why they perform a tolerance stack-up analysis.

Q: What is SolidWorks TolAnalyst?
A: TolAnalyst is a tolerance analysis application provided in SolidWorks 2008 Office Premium that determines the effects that dimensions and tolerances have on parts and assemblies. The TolAnalyst tools let you perform maximum and minimum tolerance stack-up analysis on parts and assemblies.

Q: What are the key capabilities of SolidWorks TolAnalyst?
A: The key capabilities are:
- TolAnalyst displays analysis results for the critical dimension being evaluated as nominal, "worst case" maximum/minimum as well as RSS (root sum square) maximum/minimum. RSS maximum/minimum is a statistical probability of what the maximum and minimum critical dimension will be.
- Critical dimension "worst-case" maximum/minimum is also automatically displayed in the graphics window.
- In addition, the assembly will be displayed as a "reduced assembly", which shows only those components involved in the stack-up analysis. This makes it easier to see what going on.
- There is also functionality available to highlight the contributing features and tolerances – features and tolerances that impact the critical dimension being evaluated.
- A contributor list, by percentage affect on the critical dimension, is output for both maximum and minimum values. The contributor list lets you know which "tolerance features" (from DimXpert for Parts) and tolerances have the greatest effect on the critical dimension values. In this way, the user has an good idea of which tolerances to tweak to fix fit and function problems.
- Finally, you can export analysis to Excel.

Q: Who needs TolAnalyst?
A: TolAnalyst is for:
- **Anyone who currently performs "manual" tolerance stack-up Analyses**
  Anyone who performs "manual" tolerance analyses – this includes hand calculations and spreadsheets
- **Design high precision components that require strict adherence to tolerances to function properly**
  A disk drive or a mechanical watch (gears and springs) are good examples of assemblies that contain high precision components. In a disk drive, the reading head wisps back and forth at high speed while skimming just microns above the surface of the disk. Incorrect tolerancing here could mean in the head contacting the disk, ultimately resulting in a disastrous disk crash.
  Also included here is machines that require high precision. For example, machines that automate the assembly of computer boards. Location of the board as it moves from station to station, and accuracy of the movement and location of the robotic assembly arm is vital.
- **Design products to be produced in high volume and can't afford assembly fit problems in assembly**
  Consumer products such as cameras and cell phones are good examples of mass produced items that rely on proper GD&T to ensure the products fit together, look good, and function properly. Sometimes 10's of

thousands of the same product is produced per day. Variations in tolerances could result in 1000's of scrapped parts in a short amount of time. When the risks are this great, you can be sure that the GD&T is being employed.

- **Anyone who must correctly dimension and tolerance designs because of particular applications such as military, Department of Energy (nuclear), etc.**
Some designers are bound by the types of designs or agencies they work for to GD&T

- **Anyone who currently suffers from assembly fit problems**

Q: How would the designer typically use TolAnalyst?
A: Below is an image showing the TolAnalyst workflow.
First you use DimXpert for Parts to apply dimensions and tolerances to the parts in an assembly. TolAnalyst automatically uses this data in its analysis calculations. TolAnalyst considers plus/minus and most geometric tolerancing in its calculation.
Next, create the "critical evaluation dimensions" that you want to analyze. For example, in Figure 1 below, the clearance (shown as "2") between the yellow and blue rollers.
Next, the order in which the parts are assembled as well as the order of the assembly mates is setup.
Then run the stack-up analysis. TolAnalyst will calculate the results and display maximum and minimum tolerance stack-ups on the screen in the graphics window. In the Figure 1, the maximum clearance is shown as "6.05" and the minimum clearance is shown as "-1.55" which is an interference.
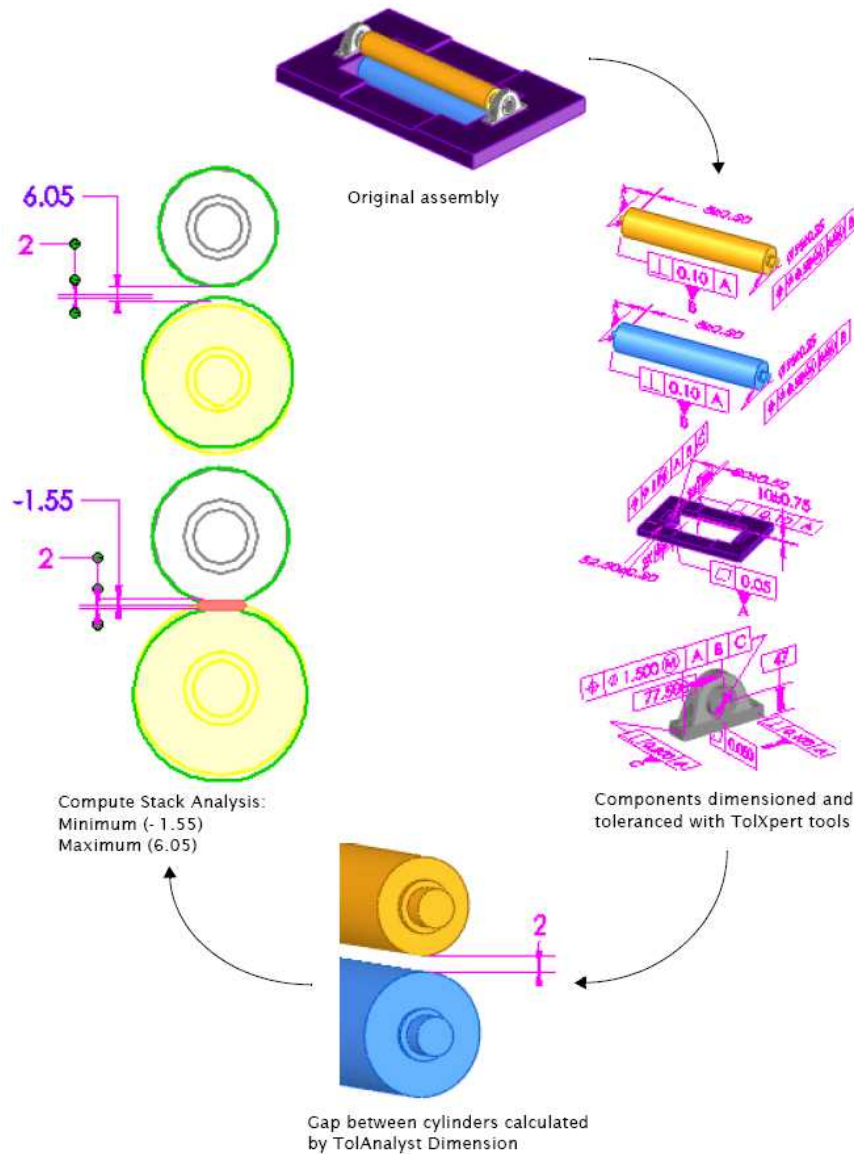
TolAnalyst Workflow

Original assembly

6.05

-1.55

Compute Stack Analysis:
Minimum (- 1.55)
Maximum (6.05)

Components dimensioned and
toleranced with TolXpert tools

2

Gap between cylinders calculated
by TolAnalyst Dimension

Figure 1

Q: What differentiates TolAnalyst from other tolerance analysis products on the market?
A: Here are the key points that differentiate TolAnalyst:

- **Eliminates error-prone hand calculations** – DimXpert for Parts GD&T information is automatically "loaded" into TolAnalyst. There is no need to do hand calculations or enter data manually into a program or spreadsheet. Manual methods are slow and error prone.
- **Automatically identifies key contributors** - TolAnalyst gives you feedback as to which tolerances most greatly affect the critical dimension "worst-case" max/min. It's easier for the designer to figure out what needs

to be tweaked. After tweaking the tolerance he can then run the analysis immediately.

- **Very fast tolerance stack-up iterations** - Because TolAnalyst is part of SolidWorks, there is no need to import or manually enter tolerance data from another system.
- **The calculations in TolAnalyst are very fast** – it sometimes takes only a few seconds to compute and display the results of the tolerance stack-up analysis
- **Graphically displays results in SolidWorks**- Contributor chain is displayed graphically to show you which features most greatly affect the analysis.
- **TolAnalyst solves for Max/Min "worst-case" in relation to how parts are positioned in the assembly.** Many "tolerance analysis" packages solve for Max/Min by merely rebuilding the CAD models at the maximum or minimum dimensions. This method will not yield correct results in many cases TolAnalyst solves Max/Min "worst case" in relation to how the parts are positioned in the assembly.

  Inventor and PTC can't solve Max/Min "worst case" in the context of assembly – they "grow" or "shrink" all parts to Max/Min. In the example here, all 7 blocks in the assembly are the same. Merely rebuilding the models at their maximum and minimum will not yield the correct results of "worst-case" max/min.
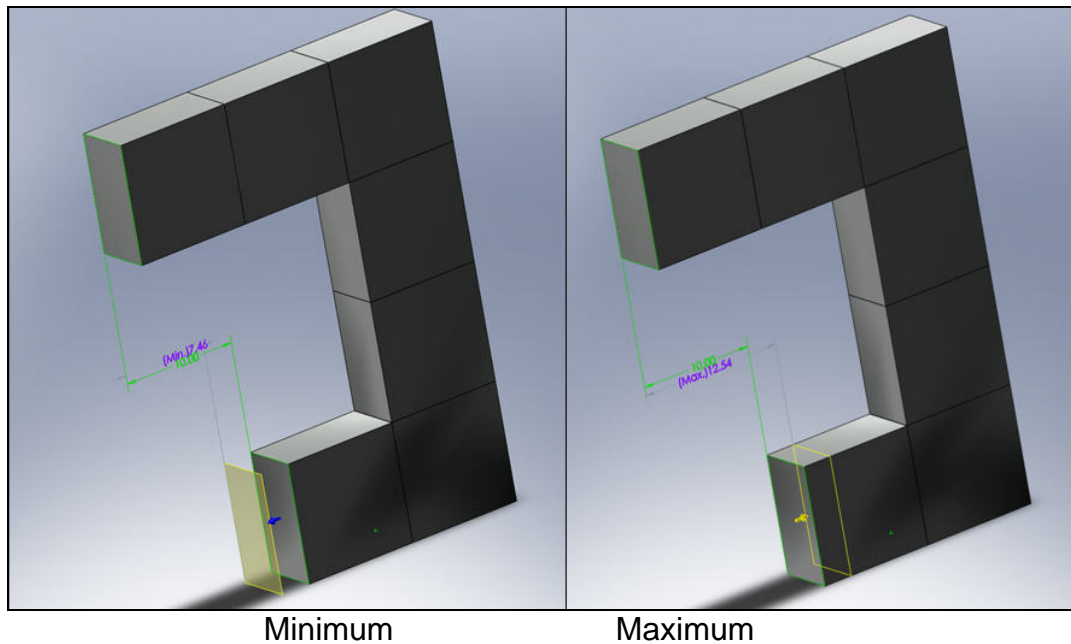

Minimum   Maximum
Figure 2

(see **Figure 2**) TolAnalyst solves for true true max/min "worst-case" condition. For minimum "worst-case", the top row would have to "shrink", and the bottom row would "grow". Conversely, for maximum "worst-case", the top row would have to "grow", and the bottom row would "shrink". Inventor and PTC can't grow one row while shrinking other because their "growing" or "shrinking" happens in part, irrespective of how the parts are positioned in the assembly.

Q: What are the key benefits of TolAnalyst?
A: Here are the key things that differentiate TolAnalyst:
- Reduces amount of prototyping and testing for assembly fit – you can find tolerance issues you wouldn't even find in physical prototyping because TolAnalyst solves for max/min worst case, and the physical protype might not represent worst-case.
- Decreases manufacturing costs by verifying tolernace schemes – in this way looser tolerances can be used where tight tolerances are not needed. This will save money in manufacturing – example: a square piece of plate steel that is torch cut vs. machined on a milling machine.
- Very fast tolerance stack-up iterations – the calculations in TolAnalyst are very fast. Sometimes just a few seconds.
- Identifies key contributors - TolAnalyst gives you feedback as to which tolerances most greatly affect the critical dimension "worst-case" max/min. It's easier for the designer to figure out what needs to be tweaked. After tweaking the tolerance he can then run the analysis immediately.
- Graphically displays results. Contributor chain is displayed graphically to show you which features most greatly affect the analysis.
- Eliminates error-prone hand calculations – DimXpert for Parts GD&T information is leveraged automatically by TolAnalyst. There is no need to do hand calculations or enter data manually into a program or spreadsheet. Manual methods are slow and error prone.
- TolAnalyst solves for Max/Min "worst-case" in relation to how parts are positioned in the assembly.

Q: When will TolAnalyst be available?
A: TolAnalyst is available with the SolidWorks 2008 Beta release.

Q: In detail, what TolAnalyst <u>CAN</u> do…
A: TolAnalyst can do:
- Max/Min "worst-case" results
- Max/Min RSS results
- Geometric tolerance, bonus tolerance and datum shift (at MMC) are considered in analysis
- TolAnalyst supports its own version of coincident and concentric mates
- Supports DimXpert features including slot, width, and notch features

- The only SW mate type considered is a distance mate applied between two planes that are associated to DimXpert features
- TA supports pattern mates, for example, hole pattern to hole pattern, and one to many relationships, for example, mating a plane to two coplanar planes from the same or different parts
- Orientation and angular plus minus tolerances are supported as an option
- Supported dimensions for TolAnalyst evaluation dimension:
    - Cylinder
    - Simple Hole
    - Counterbore Hole
    - Countersink Hole
    - Slot
    - Boss
    - Plane
    - Notch
    - Width
    - Cone
    - When applying dimensions to axial features the axes must be parallel

Q: In detail, what TolAnalyst <u>CAN</u> <u>NOT</u> do…

A: TolAnalyst cannot do:
- No Monte Carlo analysis
- Deformation, temperature and gravity not considered
- 3-bar link and "jiggle-fit" not supported
- TolAnalyst critical dimensions not supported:
    – Fillets
    – Fillet patterns
    – Hole patterns
    – Chamfers
    – Chamfer patterns
    – Contoured surfaces
    – Virtual intersects (point intersection between hole and plane, line intersection between two planes, plane intersection between cone and cylinder
    – In general, limited by things that can be dimensioned in DimXpert (i.e. can't dimension a sphere)