

# HCL Tolerance Stack Analysis Capability

21<sup>ST</sup> CENTURY TECHNOLOGIES



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# HCL Tolerance Stack Analysis Capability Overview



## Overall TSA Experience

- **10+ years** experience in TSA
- **Industries Served:** Automotive, Aerospace, Medical Devices, Industrial Manufacturing, Telecom, Consumer Electronics, Semiconductors etc.



## Projects Delivered

- Successfully completed **250+ projects** in TSA across domains
- TSA performed for **10+ NPD projects**



## People and Certifications

- **400+ Engineers** having experience in TSA
- **8+ ASME GD&T** certified professionals



## Experience on TSA Tools

- 1D: HCL Proprietary TSA Tools, Client Specific Tools
- 2D / 3D: **Top 3 TSA tools** – **CETOL, VIS-VSA, Sigmund Works & CAD Tools**



## Areas of Engagement

- **NPD Projects** – perform TSA before production
- Field Failure Investigation
- Perform TSA to determine product costing



# HCL's Approach to Tolerance Stack Analysis

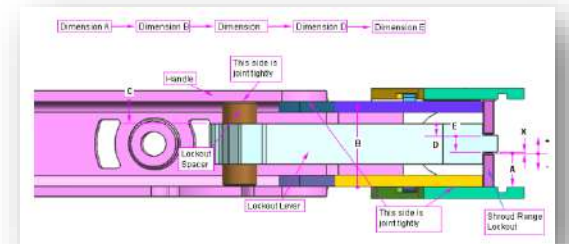
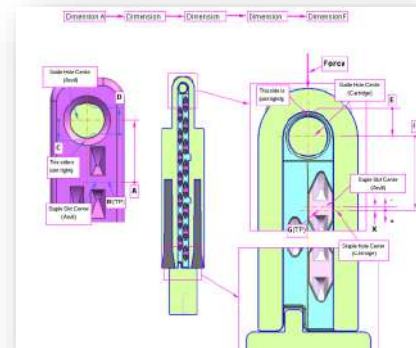
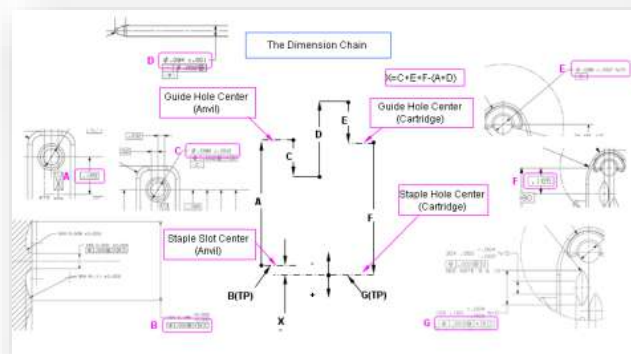
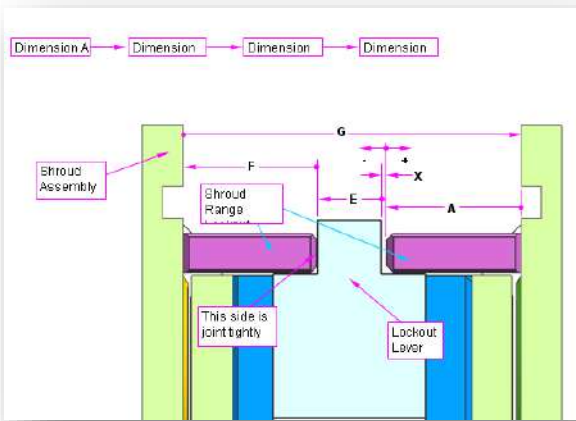


# Case Study 1: Reusable Stapler

## Tolerance Loop Purpose

- Tolerance analysis for identifying critical gaps which affects the performance of device
- Inputs for GD&T

Tolerance Stack-up Analysis												
Part/Name/Part No./Drawing No.		Var No. & Feature/Zone	Variables	Variables Description	Mean	Length or Term	Symmetrical Tolerance	±σ or Actual	Distribution Type Normal(B) Uniform(U)	Standard Deviation	Contribution %	Sensitivity Coefficient
Tolerance ID: 1												
Gap Description: Range lockout to lockout lever gap												
Input Sigma Level: 3												
Date: 24 May '10												
Version: 2.0												
Analysis table												
9	28	10	28	Range lockout length	0.212	S	0.005	A	N	0.0050	26.9%	1
10	28	10	28	Shroud pocket length	0.0205	S	0.0015	A	N	0.00150	2.27%	1
11	28	10	28	Pinhead dimension 1	0.278	S	0.005	A	N	0.00500	9.97%	1
12	28	10	28	Pinhead dimension 2	0.112	S	0.002	A	N	0.00200	9.97%	1
13	28	10	28	Pinhead dimension 3	0.263	S	0.005	A	N	0.0050	26.9%	1
14	28	10	28	Spacer distance	0.103	S	0.002	A	N	0.00200	4.87%	1
15	28	10	28	Lockout lever length	0.027	S	0.005	A	N	0.0050	26.9%	1
Mean GAP					0.002	Clear Content	Clear Sensitivity	Calculat	Total:		100.0%	
Upper Limit of GAP												
Lower Limit of GAP					0							
Repeat												
Loop Picture												
Summary												
Mean GAP: 0.002												
Standard Deviation: 0.004217												
DFUL: 0.7167308												
Z-1 Score: -0.27												
Worst Case												
Lower Limit: 0.002												
Upper Limit: 0.002												
Comments: The current dimensions will lead to 0.03% tolerance												

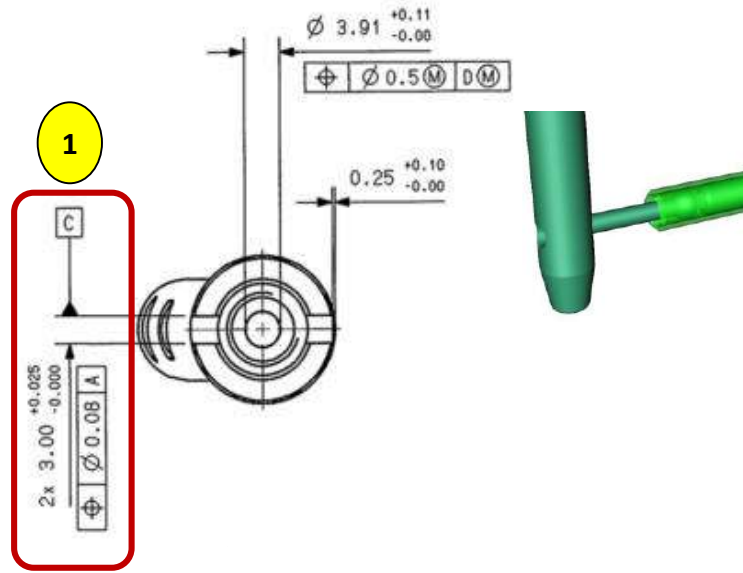


# Case Study 2: Torch Nail Jig

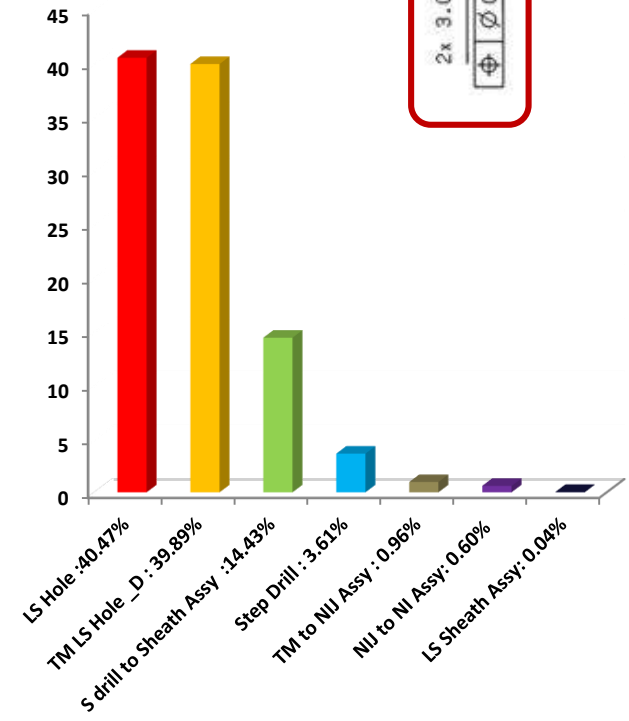
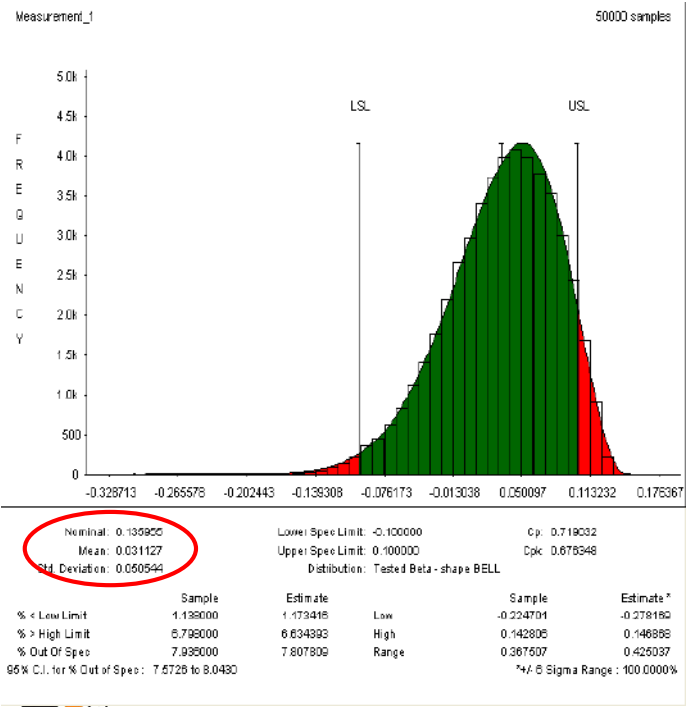
## Tolerance Loop Purpose

- Identify drill shift of implant hole
- identify hole size due to drill and sheath variations

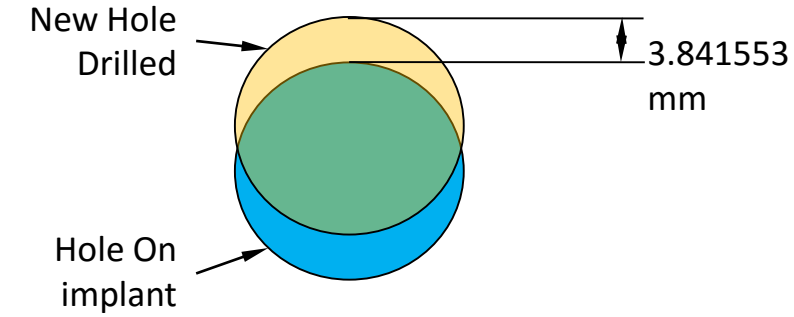
## Results



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- TM LS Hole \_D : 39.89%
- S drill to Sheath Assy : 14.43%
- Step Drill : 3.61%
- TM to NIJ Assy : 0.96%
- NIJ to NI Assy : 0.60%
- LS Sheath Assy : 0.04%



# Case Study 3: Cooler Unit 3D Analysis

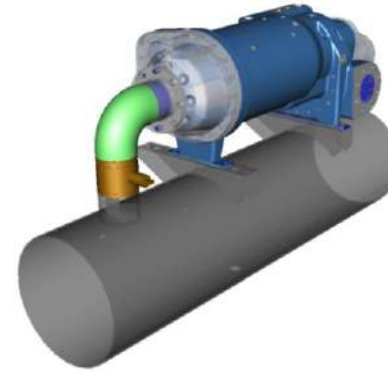
## Scope

- Gap analyzed to identify the failure limits

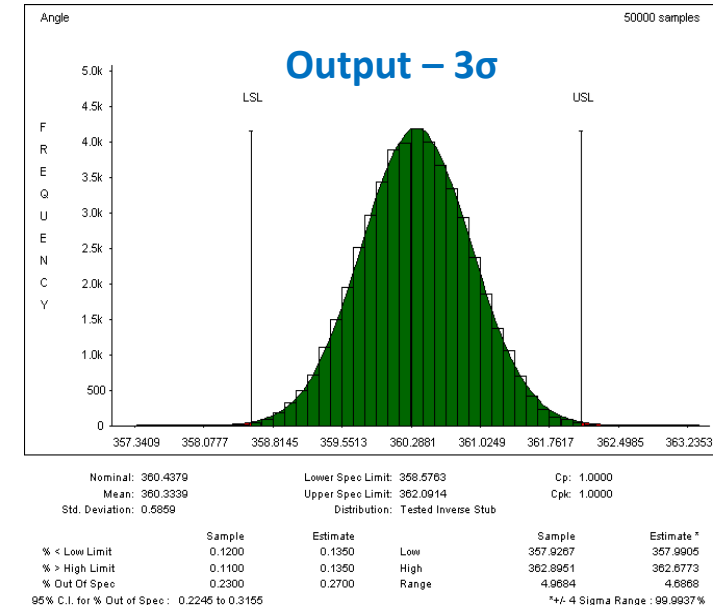
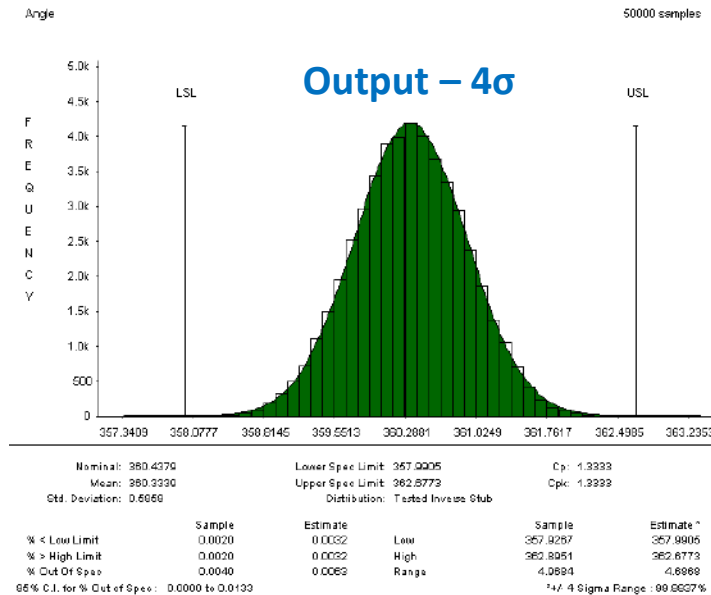
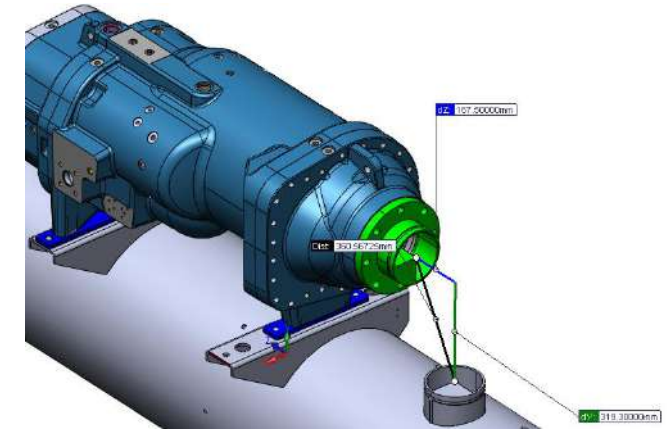
## Results

Output	X		Y		Z		Angular	
	Min	Max	Min	Max	Min	Max	Min	Max
3 $\sigma$	165.0613	169.8693	317.7809	320.5702	-3.1683	3.1503	358.5763	362.0914
4 $\sigma$	164.2600	170.6706	317.3160	321.0351	-4.2214	4.2034	357.9905	362.6773
6 $\sigma$	162.6590	172.2715	316.3872	321.9639	-6.3253	6.3073	356.8200	363.8477

VSA Model



CAD Model



# GD&T in Drawings

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- Extensively use ASME Y14.5M-1994 in the drawings
- Widely use the below tolerance types:
  - ✓ Form tolerance (Straightness, Flatness)
  - ✓ Profile tolerance (Profile of a line, profile of a surface)
  - ✓ Orientation (Angularity, Perpendicularity & parallelism)
  - ✓ Location (Position, Symmetry)

- Sample drawings attached:



Drawing 1



Drawing 3

- Uses customer specific Design Verification Workbook (DVW) to specify the design intent of every dimension and perform tolerance analysis (2D and 3D) to verify the design:
  - ✓ Layouts/Overlays
  - ✓ Linear tol-stack



# GD&T in Drawings

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# THANK YOU!

GET IN TOUCH WITH US!

