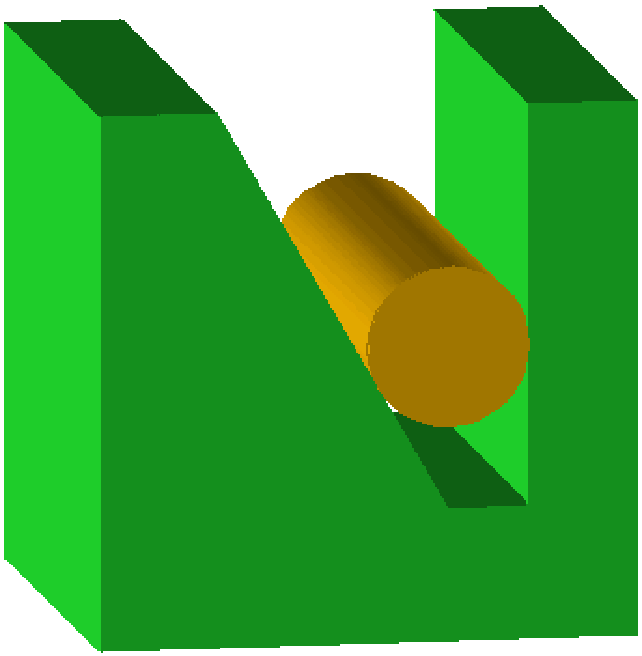
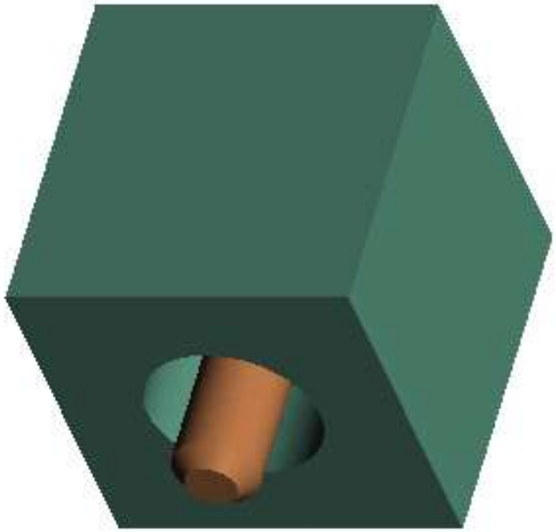
CETOL 6σ Integration with Optimus

What is Manufacturing Variation?

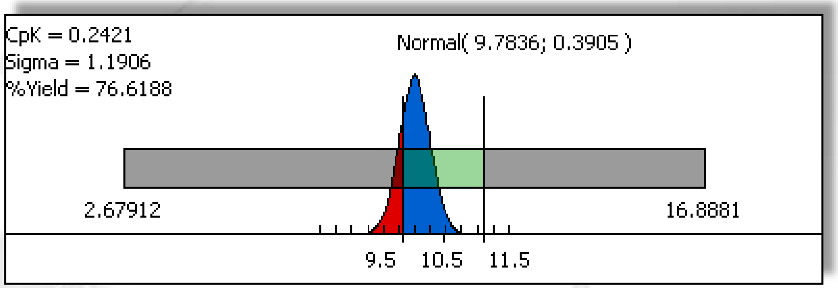




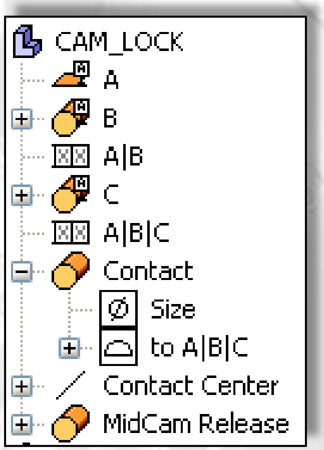
Imperfections in geometry and clearances between parts cause undesirable adjustments within assemblies

What is CETOL 6σ Addressing?

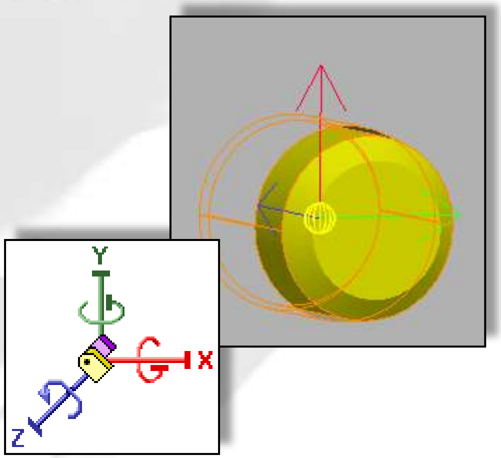
The assembly-level tolerance is driven by:



1) Part-level dimensioning & tolerance scheme

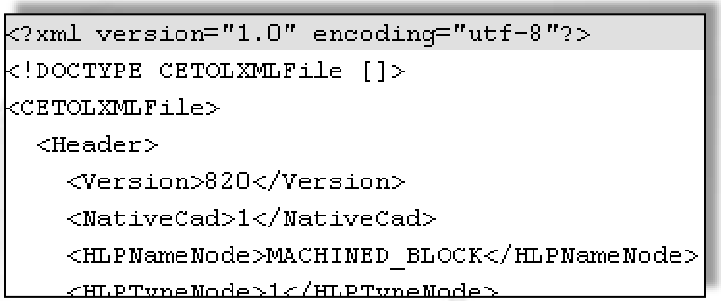


2) Assembly-level kinematic relationships between contacting surfaces



Input Variables from CETOL 6σ

- CETOL is driven by an XML-based model file (.CXM)
  - Created using the CETOL Modeler
  - Rich with unique assembly constraint and tolerance variables

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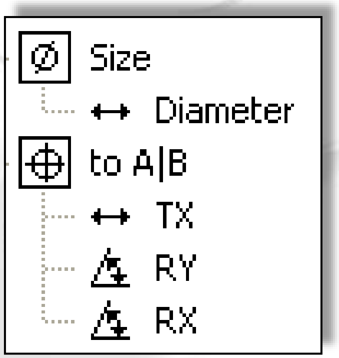
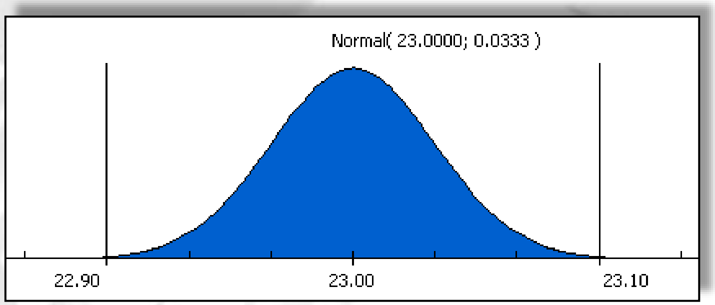
<!DOCTYPE CETOLXMLFile []>
<CETOLXMLFile>
  <Header>
    <Version>820</Version>
    <NativeCad>1</NativeCad>
    <HLPNameNode>MACHINED_BLOCK</HLPNameNode>
    <HLPTypeNode>1</HLPTypeNode>
```


- Input Variables to Optimus
  - Size, dimension, & GD&T tolerances
  - Feature sizes & positions



  - Design nominal values
  - Design nominal manufacturing distribution parameters

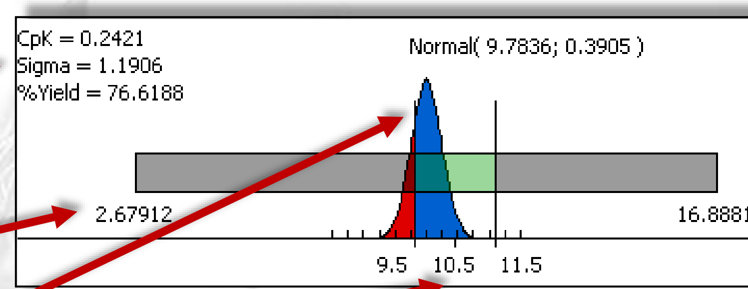


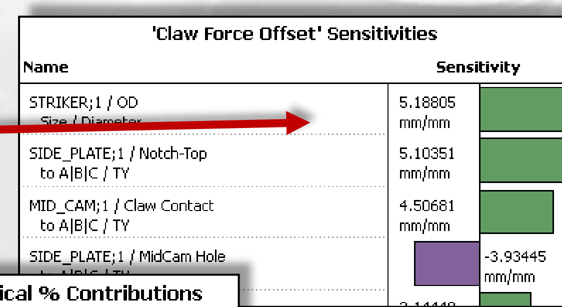
CETOL 6σ Output Variables

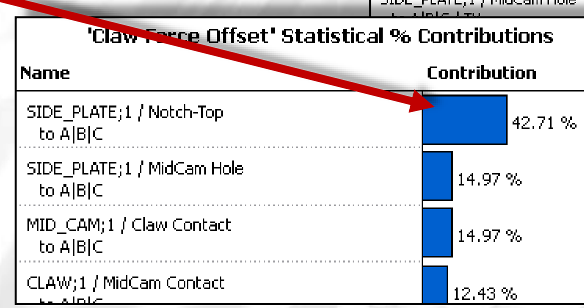
Sigmetrix

Geometric variation-related analysis results for each measurement

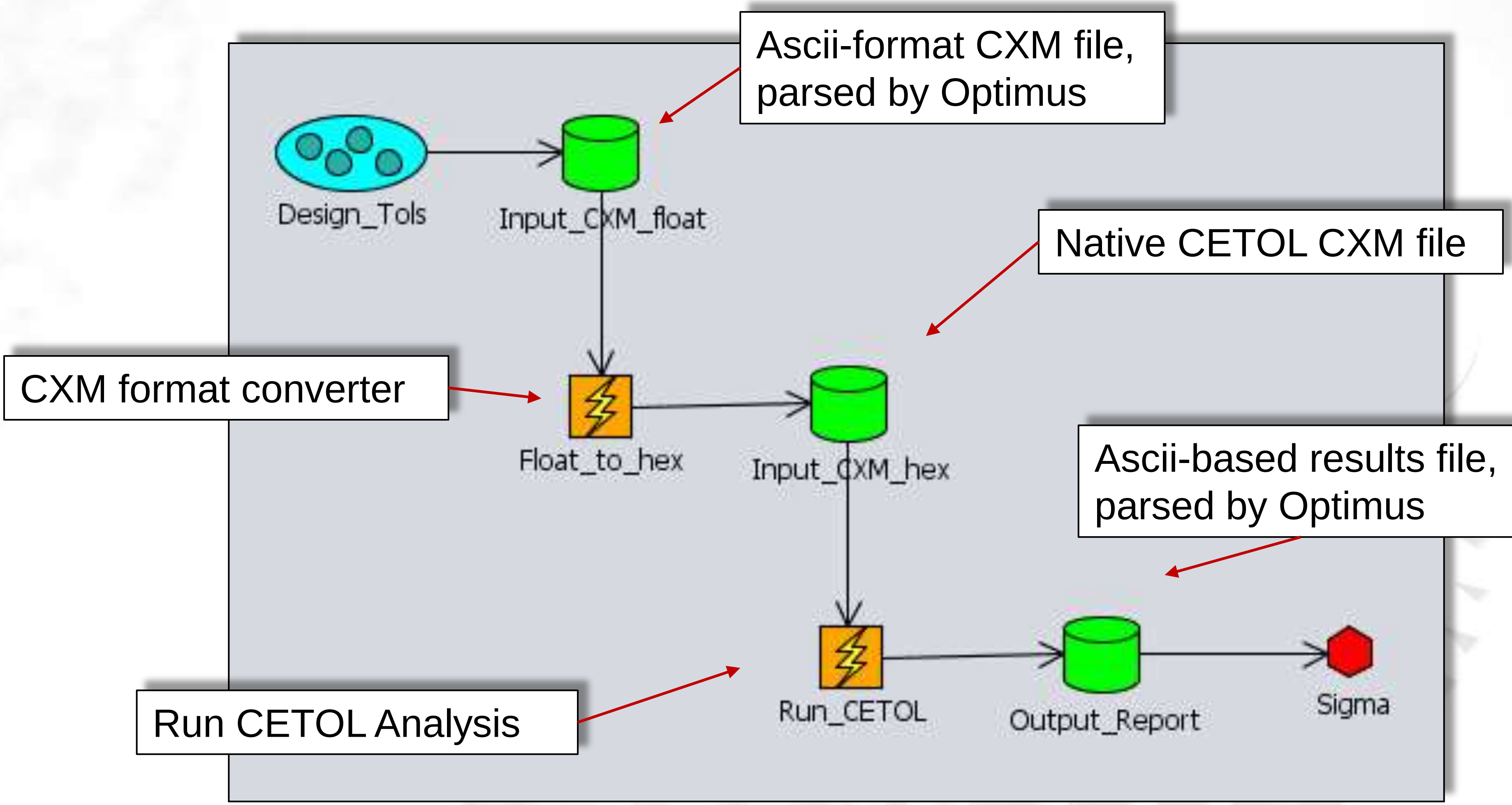
1) Quality metrics (Cp, Cpk, sigma, % yield, etc)
2) Worst-case variation limits
3) Statistical distribution parameters
4) Calculated nominals
5) Geometric sensitivities
6) Percent contributions
7) …







Basic CETOL Simulation Workflow

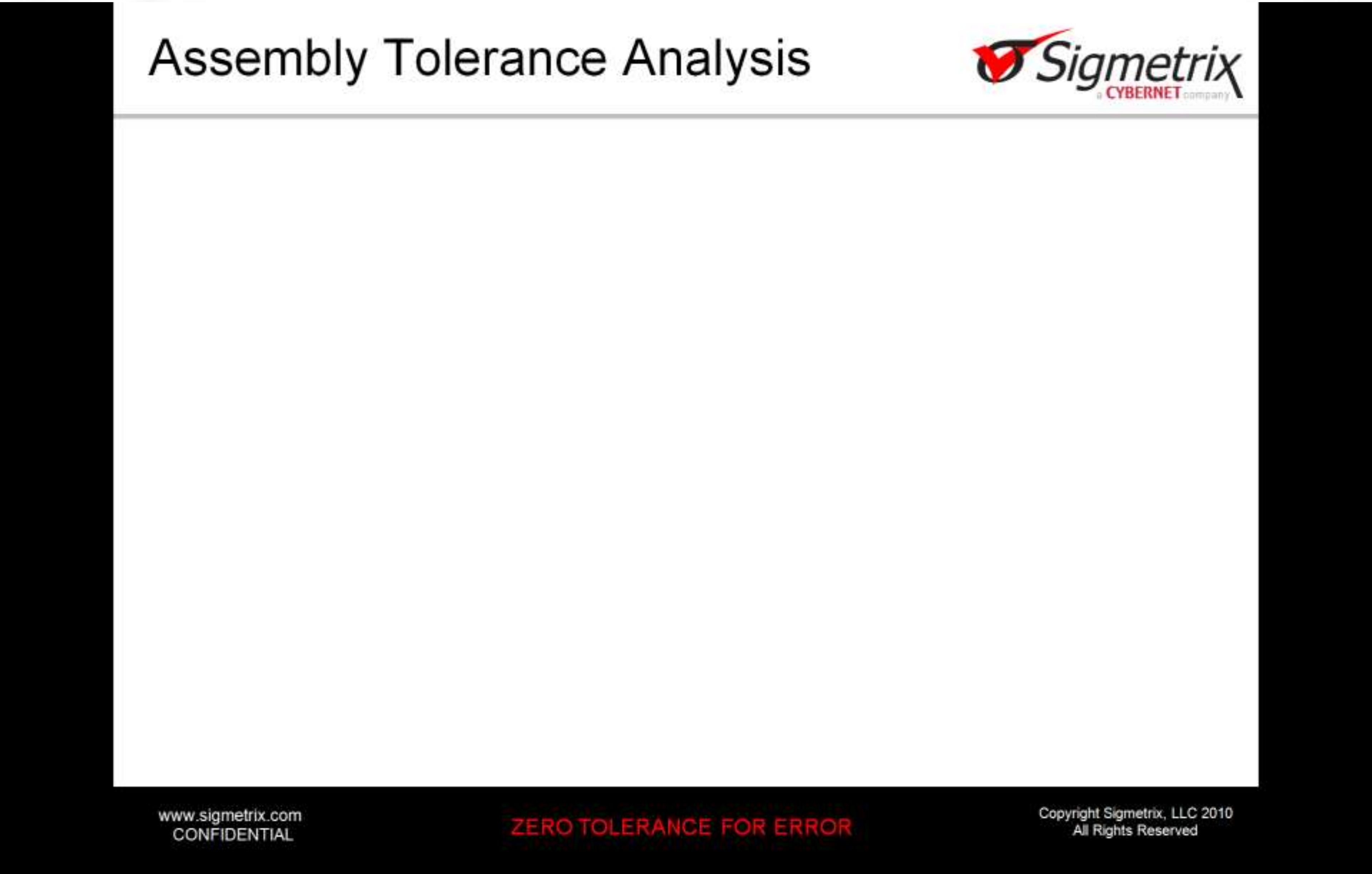


Common Applications

Include mechanical variation effects in:

1) Multi-objective performance optimization
2) Multi-physics simulation and optimization
3) Design robustness optimization
4) Manufacturing cost optimization

CETOL Example

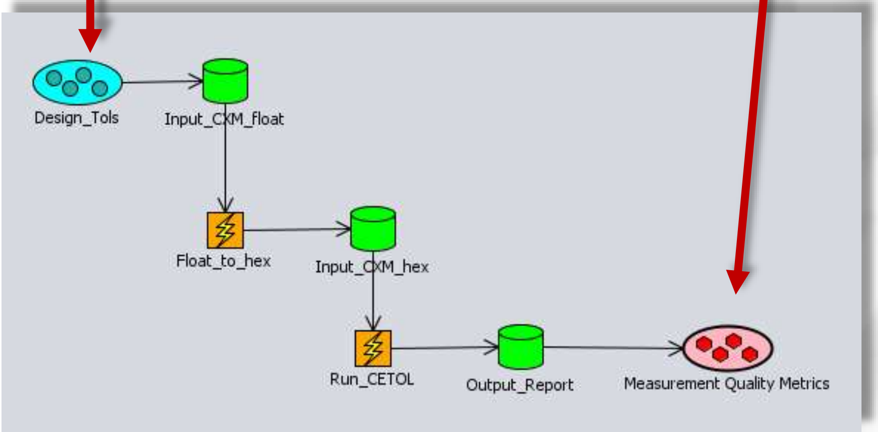


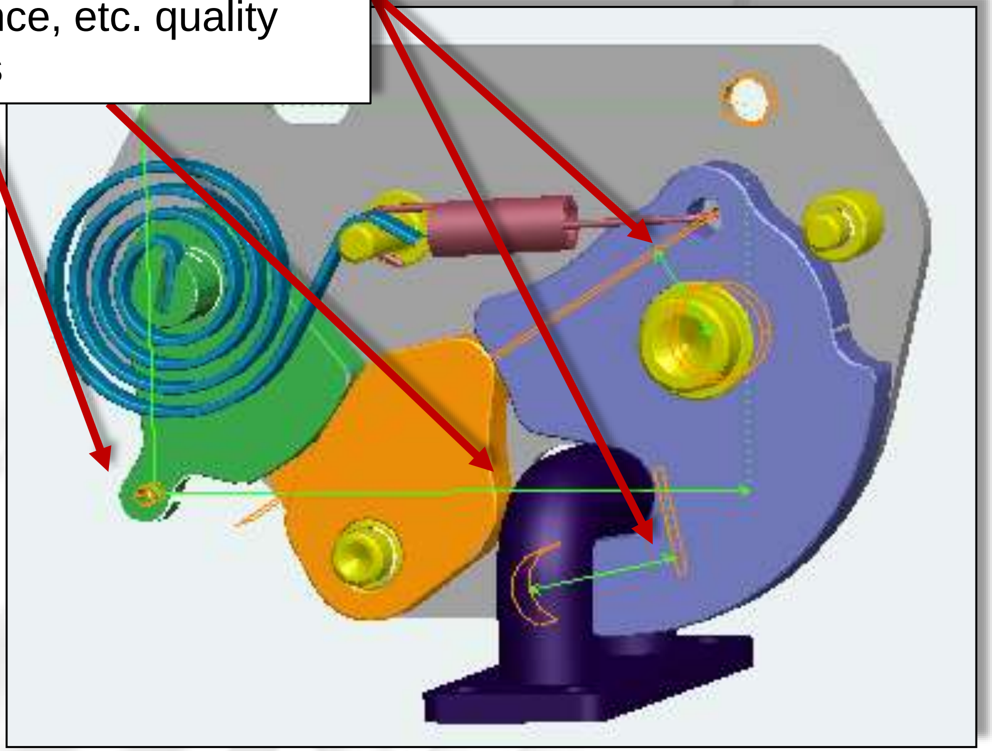
1) Multi-Objective Optimization

Objective: Determine the design tolerance values that achieve the quality targets of multiple, conflicting design goals

CETOL calculates Cable force offset, Claw to tip clearance, etc. quality metrics

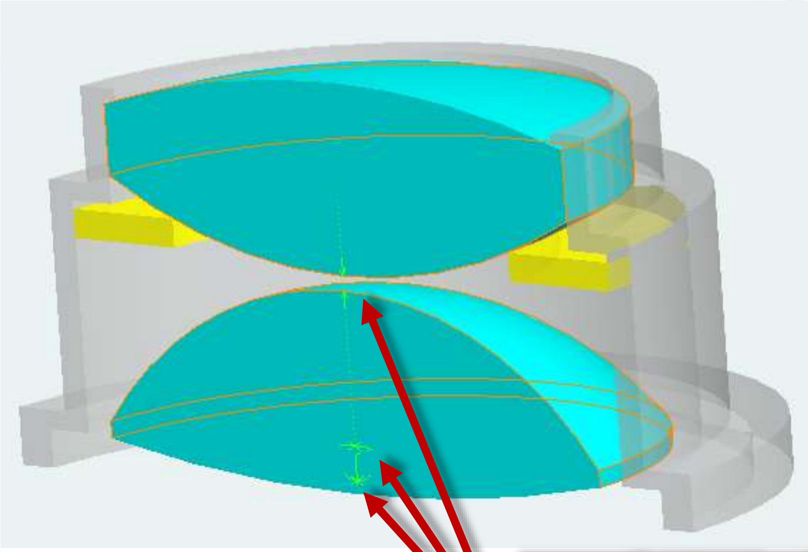
Optimus adjusts Part tolerances to achieve target quality for all measurements

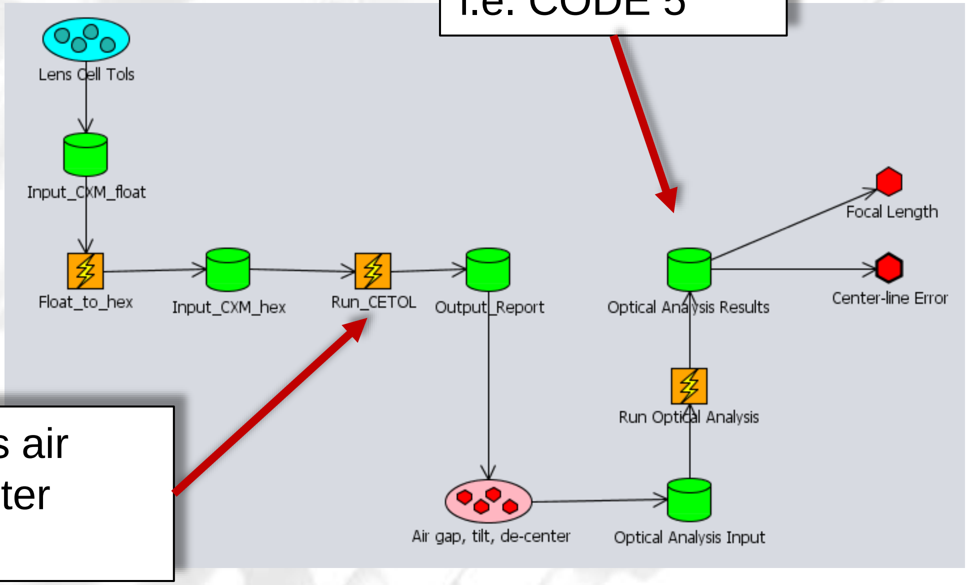




2) Multi-Physics Optimization

Objective: Determine largest design tolerance values that still achieve the optical cell focal length & center-line error maximum variation requirement





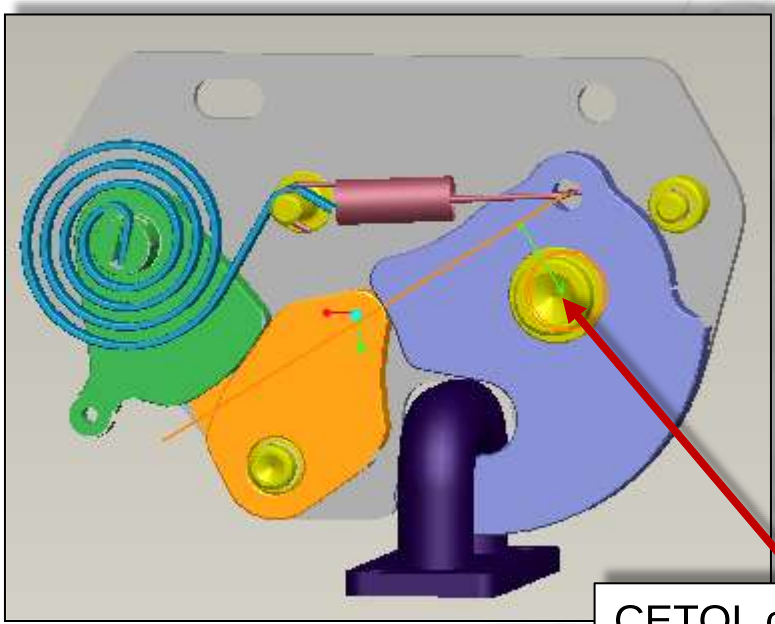
External Optical Analysis Tool i.e. CODE 5

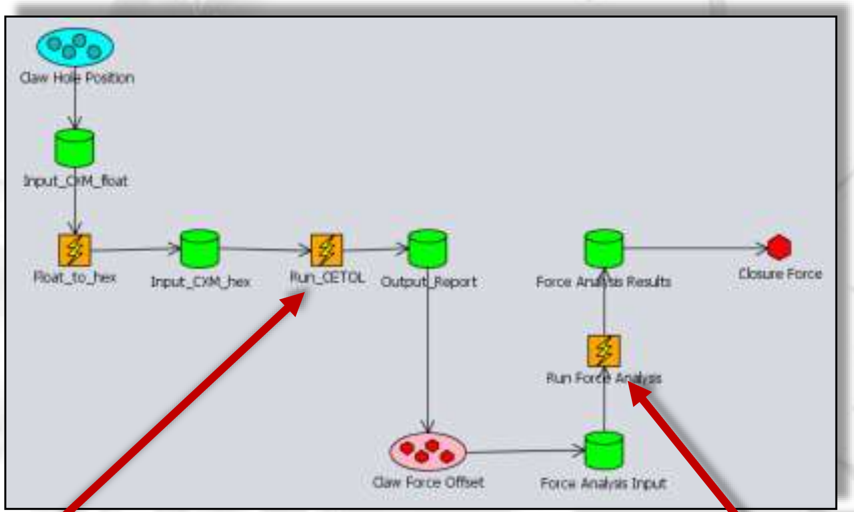
CETOL calculates air gap, tilt, & de-center variation

ZERO TOLERANCE FOR ERROR

3) Robustness Optimization

Objective: Find the location of the Claw hole feature that minimizes the claw force sensitivity to manufacturing variation.



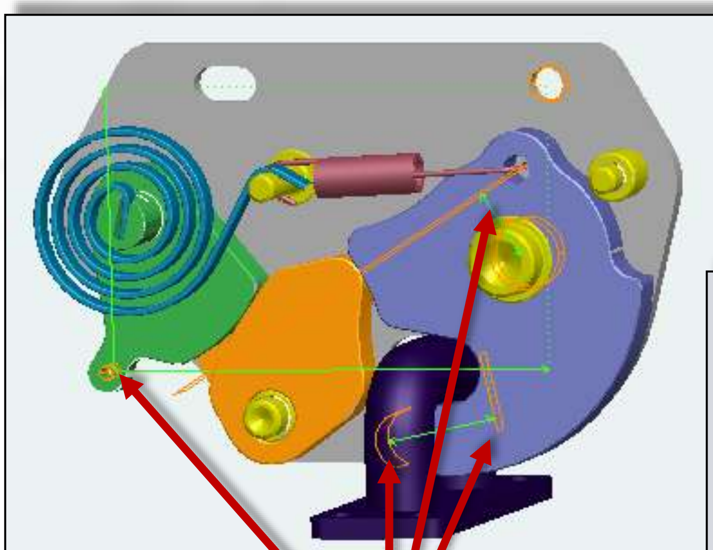


CETOL calculates Claw Force Offset variation

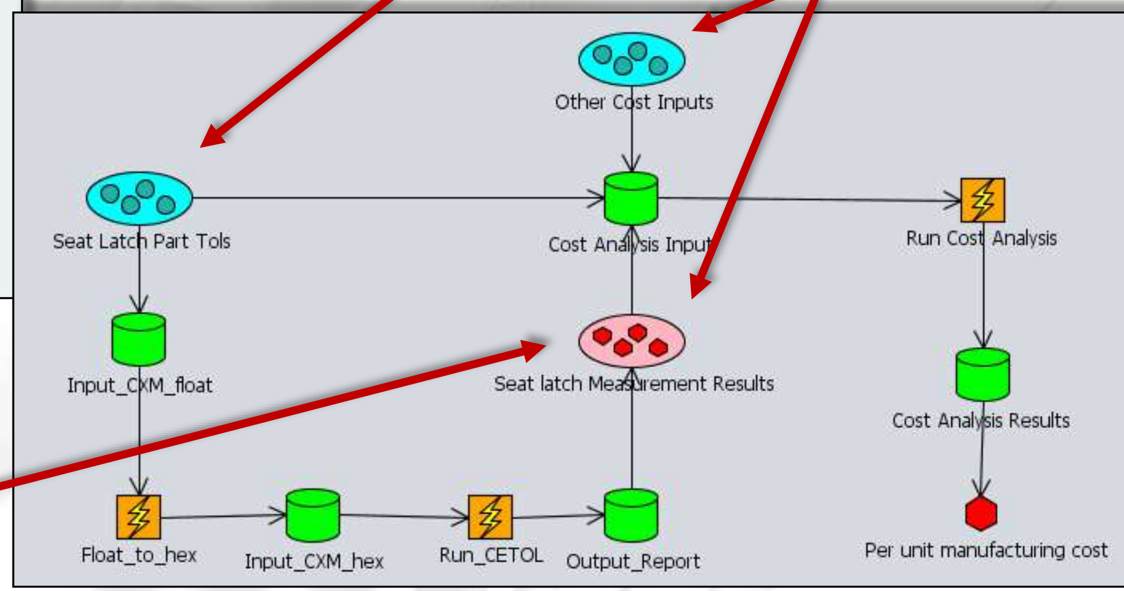
External Force Analysis Tool

4) Manufacturing Cost Optimization

Objective: Determine the design tolerance values that minimize the total cost of manufacturing the seat latch



Part tolerance, variation results, & other cost inputs fed to external cost estimation tool



CETOL calculates Cable force offset, Claw to tip clearance, etc. variation

Analyze. Optimize. Understand.