

EN1740 Computer Aided Visualization and Design

Spring 2012

4/12/2012

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Last Time:

- Design Analysis
 - Clearance/Interference Checking
 - Sensitivity/Feasibility/Optimization
- Intro to GD&T

Tonight:

- Group Project Overview
- Tolerance Analysis
 - CETOL
- Intro to GD&T

Supporting Reading:

- Second half of Chapt. 4 (pg 96-112)
- Chapt. 6
- Chapt. 8

Group Project Subjects

Need one group for each

- Blades
- Hub
- Gear train
- Base
- Collapsible stand
- Tail (Horizontal Furling)
 - Fluids
 - Structures
- Structure for Batteries, Inverter and Controls
- BBS





Manufacturing Tolerances

Nothing's perfect

Fig. 4-50, B. A. Wilson, GD&T App. And Intr., 2010

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Manufacturing Tolerance

Components must specify allowable tolerances

- Tolerances can be specified in a number of ways
 - Dimensional
 - Limits
 - Unilateral
 - Bilateral
 - Geometric
 - Form
 - Orientation
 - Position



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Design Tolerance Analysis

- How dimensional variation affects component/product performance
 - Critical to everything manufactured
 - Example Change in part dimensions affect spring pocket height which effects output pressure
- Use CETOL to calculate the variation in spring pocket size
 - As design evolves stackup is updated
 - Easily accounts for advanced dimensioning





- Open relief valve assembly
- Turn on Dimension Tolerances
 - Tools >Environment
 - Check Dimension Tolerances



Environment

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EXERCISE - Design Tolerance Analysis

Define part feature tolerances

- Open piston.prt
- Create a symmetric tolerance of .005 on .250 height
 - Edit feature
 - Select dimension
 - RMB > Properties
 - Set Tolerance Mode to Symmetric
 - Set Tolerance to .005



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Define part feature tolerances

• Using the steps shown previously, apply a symmetric tolerance of .008 to the thickness of the seal .080





Define part feature tolerances

• Using the steps shown previously, apply a symmetric tolerance of .003 to the height of the seal .375





Define part feature tolerances

• Using the steps shown previously, apply a symmetric tolerance of .006 to the height of the seal .850





Define tolerance study

- Back to the top level assembly
- Analysis > Tolerance Study...

🧾 RELIEF_VALVE (Activ	e) - Pro/ENGINEER Education Edition
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EXERCISE - Design Tolerance Analysis



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EXERCISE - Design Tolerance Analysis

Define tolerance study

- *STEP 1:* Define the dimension to analyze
 - Select the bottom of the housing
 - Select the bottom of the piston





Define tolerance study

- *STEP 2:* Specify dimensions that contribute to tolerance
 - As soon as the subject of the analysis is defined the system begins prompting for candidate dimensions
 - Alternate selecting parts and dimensions > Use LMB for both



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Define tolerance study

• *STEP 2 (cont.):* Specify dimensions that contribute to tolerance

- Continue selecting until all the dimension we specified tolerances for have been selected
- .850<u>+</u>.006
- .375<u>+</u>.003
- .080<u>+</u>.008
- .250<u>+</u>.005

• MMB done



EXERCISE - Design Tolerance Analysis

Go back to CETOL window

- RMB in Measurement Table > Expand All
- This will show the dimensions included in the stack

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Rename analysis and enter design objective

🐨 Tolerance Analysis powered by CETOL Technology						
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Feature1						
	0.85	0.850 ±0.006	1	1	Center	
Feature						
- A HOUSING/HOUSING2					Center	
🚊 🔲 HOUSING2						
- Feature						
	0.375	0.375 ±0.003	1	-1	Center	
Feature						

- Name the analysis something descriptive
- Note nominal dimension and tolerance set by DESIGN REQUIREMENTS
 - This is not the result of the analysis; this is where the goal is set
 - Set design tolerance to .015

EXERCISE - Design Tolerance Analysis

Define tolerance study

- Click on the Analysis Results tab
- Left pane shows graphically the results
- Right pane shows contributions from individual tolerances

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EXERCISE - Design Tolerance Analysis

Define tolerance study



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EXERCISE - Design Tolerance Analysis

Adjust tolerance objective and update

- Change the tolerance objective to .010
- Observe the change in the output (what happened to DPMU?)



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Manufacturing Tolerance

Components must specify allowable tolerances

- Tolerances can be specified in a number of ways
 - Dimensional
 - Limits
 - Unilateral
 - Bilateral
 - Geometric
 - Form
 - Orientation
 - Position

Fig. 8-1, B. A. Wilson, GD&T App. And Intr., 2010

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Geometric Dimensioning and Tolerancing (GD&T) *Introduction*

• GD&T Includes 3 types of tolerances: Form, Orientation and Position

Fig. 5-1, B. A. Wilson, GD&T App. And Intr., 2010 Fig. 7-1, B. A. Wilson, GD&T App. And Intr., 2010

Fig. 8-2, B. A. Wilson, GD&T App. And Intr., 2010

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Geometric Dimensioning and Tolerancing (GD&T)

Form Tolerances – Straightness and Flatness

Fig. 5-11, B. A. Wilson, GD&T App. And Intr., 2010 Fig. 5-27, B. A. Wilson, GD&T App. And Intr., 2010

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Geometric Dimensioning and Tolerancing (GD&T)

Form Tolerances – Circularity and Cylindricity

Fig. 5-33, B. A. Wilson, GD&T App. And Intr., 2010

Fig. 5-34, B. A. Wilson, GD&T App. And Intr., 2010

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Geometric Dimensioning and Tolerancing (GD&T)

Datums

• Datum feature references

- Labels (Letters)
- Datum features
 - Part features
- Datum
 - Theoretical (perfect) reference geometry

 Datums are required for orientation and position tol's

Fig. 6-3 & 6-4, B. A. Wilson, GD&T App. And Intr., 2010



Geometric Dimensioning and Tolerancing (GD&T)

Types of datums

• There are various types of physical features that can be used as a datum

Fig. 6-7, B. A. Wilson, GD&T App. And Intr., 2010

Fig. 6-6, B. A. Wilson, GD&T App. And Intr., 2010

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Geometric Dimensioning and Tolerancing (GD&T)

Orientation Tolerances – Angularity, Perpendicularity and Parallelism

Fig. 7-30, B. A. Wilson, GD&T App. And Intr., 2010 Fig. 7-13, B. A. Wilson, GD&T App. And Intr., 2010 Fig. 7-7, B. A. Wilson, GD&T App. And Intr., 2010

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Geometric Dimensioning and Tolerancing (GD&T)

Position tolerance requires Datums, Basic Dim's and Tolerance

Fig. 8-7 & 8-8, B. A. Wilson, GD&T App. And Intr., 2010

Datums establish how to measure the part, *Basic dimensions* state theoretical location & *Position Tolerances* state allowances

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