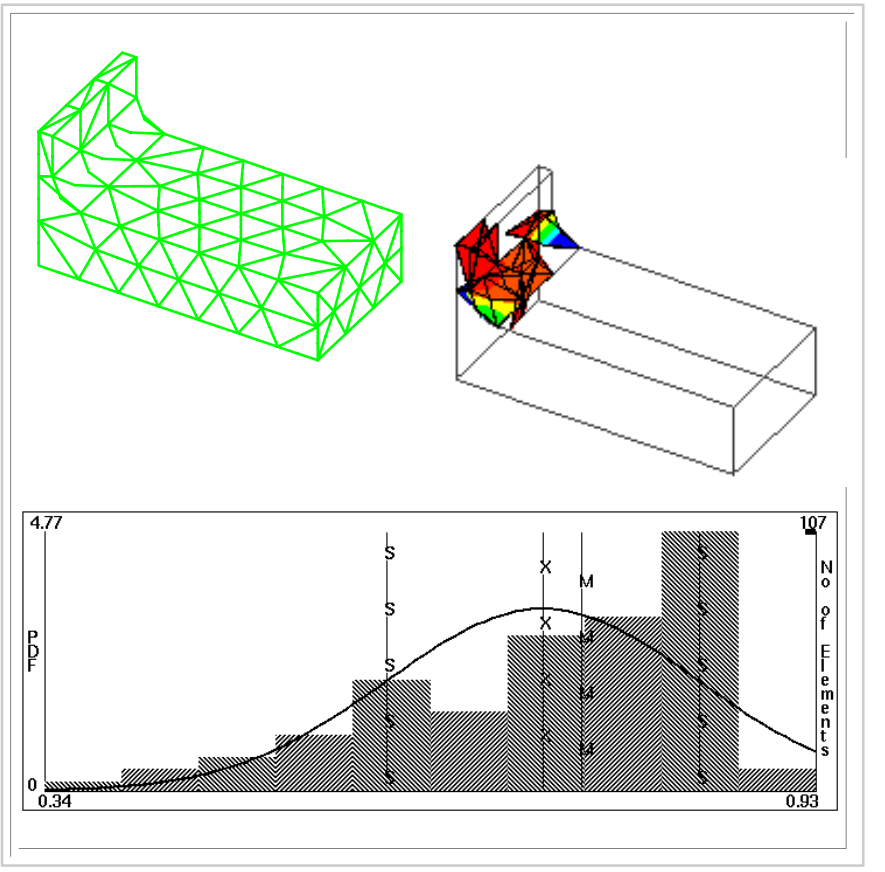


Checking Element Quality

I-DEAS™ Tutorials: Fundamental Skills

This tutorial covers techniques for checking element quality, which may affect analysis accuracy.

Learn how to:

- calculate distortion and stretch
- display distorted elements
- fix distorted elements
- use Auto Settings when meshing
- graph quality statistics

Before you begin...

Prerequisite tutorials:

- Getting Started (I-DEAS™ Multimedia Training)

  –or–

  Quick Tips to Using I-DEAS
  –and–
  Creating Parts
- Introduction to Simulation
- Managing Parts in Model Files
- Free Meshing
- Boundary Condition Sets
- Displaying Results

If you didn't start I-DEAS with a new (empty) model file, open a new one now and give it a unique name.

File
Open

Open Model File form

Model File name: any unique name
OK

Make sure you're in the following application and task:

Simulation
Master Modeler

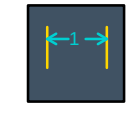
Set your units to mm.

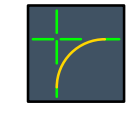
Options
Units

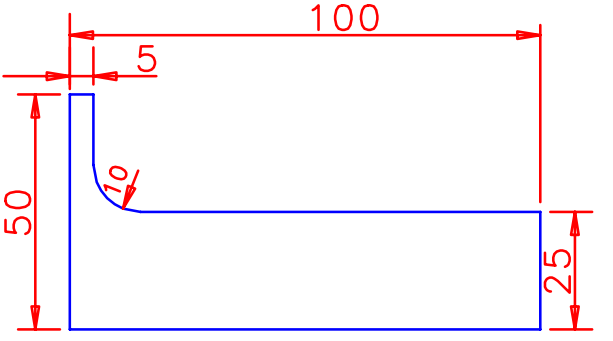
mm (*milli newton*)

What: Sketch the shape to the dimensions shown.

Hint

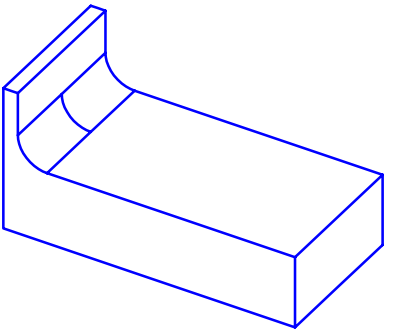




Why: The dimensions of this part and the meshing parameters used later will result in distorted elements.

What: Extrude 50mm and name the part.

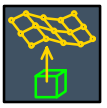
Hint

What: Create an FE model associated with the part.

Hint


Meshing



What: Turn off curvature-based refinement for all surfaces.

Why: Surface attributes such as curvature refinement must be defined on individual surfaces, not on the volume definition.

Hint

 *All*

 *Free Options...*
Curvature Based Length

 *None*

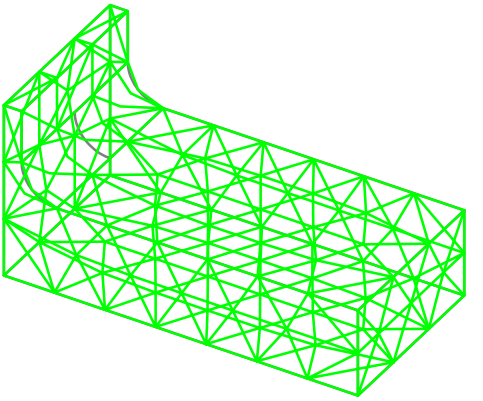
What: Mesh the volume with 15mm elements.

Hint

 *Element Length*: 15

Continued on next page...

Modify Mesh Preview form



Keep Mesh

Save your model file.

File
Save

Warning!
If you are prompted by I-DEAS to save your model file, respond:

No

Save only when the tutorial instructions tell you to—not when I-DEAS prompts for a save.

Why:
If you make a mistake at any time between saves and can't recover, you can reopen your model file to the last save and start over from that point.

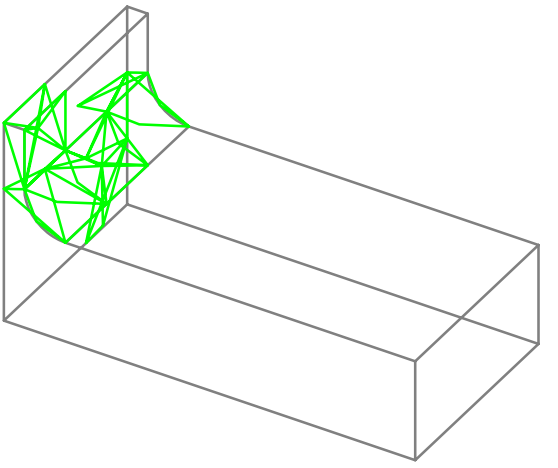
Hint
To reopen your model file to the previous save, press Control-Z.

Calculate distortion and stretch 1 of 3

Distorted elements may affect the accuracy of an analysis. The seriousness of the effect depends on many factors, such as:

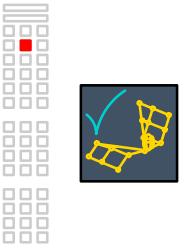
- the analysis type
- the loading
- where the distorted elements are located in the model

There are several element quality checks you can make. In this section, you'll learn how to make these checks and how to improve the model.



What: Calculate the distortion and stretch of the elements, listing the elements below selected threshold values.

How:



All

Element Quality Checks form

Distortion

.8

Stretch

.4

(to generate report in *I-DEAS List Window*)

Dismiss

Check *I-DEAS List*.
Examine the distortion and stretch values.

Things to notice

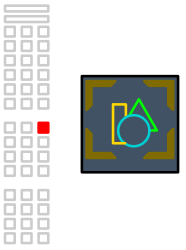
Notice that the model appears unchanged, but that there is information in the *I-DEAS List* window.

Values are normally between 0.0 and 1.0; with distortion/stretch being worse as the value approaches zero. Severe distortion can even give negative values. In this mesh, with single elements around the ninety-degree radius, you'll have some severely distorted elements.

Notice, too, that the elements listed are stored in a group called "output."

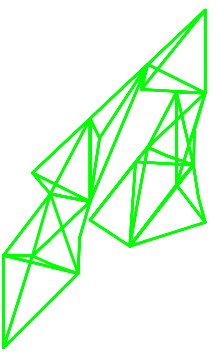
What: Display the most distorted elements to see where they're located.

How:



Use Group

Output



Things to notice

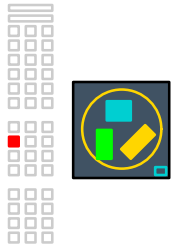
Your mesh elements may not exactly match the elements shown above.

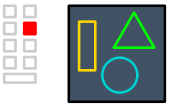
When you calculated the distortion values, the program automatically created a group of elements resulting from the output of the calculation.

What: Create a group containing the part edges.

Why: To see where these elements are in the part, it will help to display them with the part edges.

How:





Filter

Selection Filter form

Edge...

Pick Only

All

name: Distorted Elements

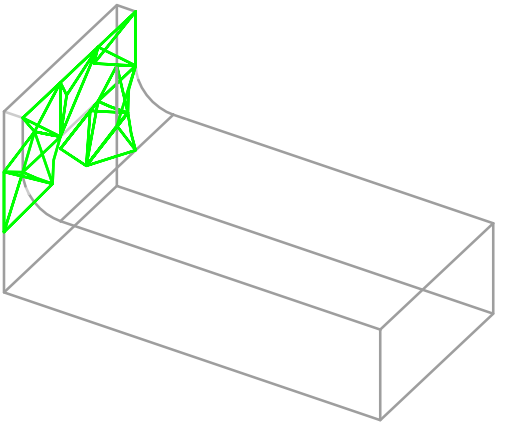
What: Add the distorted elements to the group.

How:

Use Group

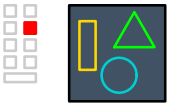
Output

What: Display the current group.



Using groups to display selected entities is a useful technique.

What: Display everything.



Close

A useful technique is to display a shaded contour plot of the distorted elements. It shows the location and the value of distortion.

What: Create result sets containing distortion and stretch values.

How:


Post Processing


Distortion


Distortion Values


(accept defaults for all 5 id lines)


Stretch


Stretch Values


(accept all defaults)

Why: With the distortion and stretch values stored in result sets, they can be displayed the same way as stress results.

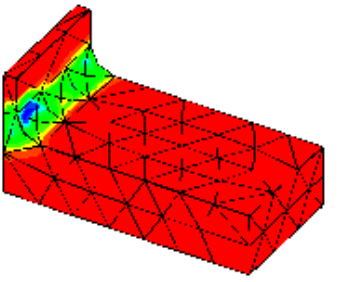
What: Display the distortion and stress results.

Hint

 Distortion Values

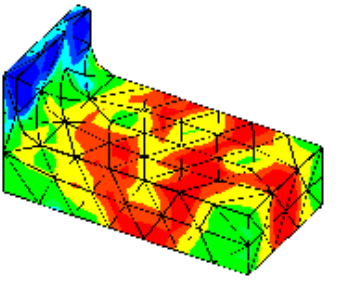
 *Display Results*

 *Deformation Results*: *Clear*



 Stretch Values

 *Display Results*



Remember Lower values of distortion and stretch are worse, shown as blue, not red as with stresses.

Things to notice

Distortion tends to be worse in the area of the curved fillet. Stretch tends to be worse in the area of the thin side wall.

You may define the color bar using model units instead of percent of range to read distortion and stretch values directly off the color bar. To interpret actual values, you should display non-averaged values.

What: Display the distortion results on only the previous stored group of elements.

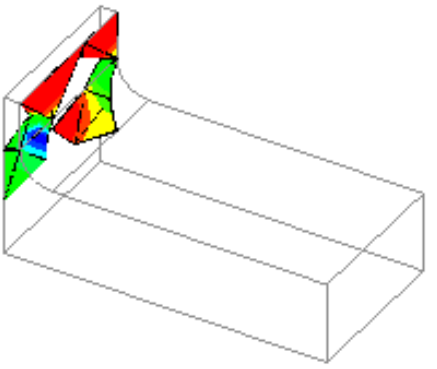
Why: Although distortion and stretch result sets contain values for every element, it helps to see distorted elements inside the model by only displaying the values on the group previously identified as the worst elements.

How:

Use Group

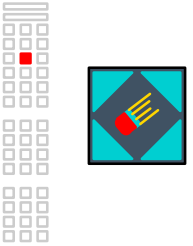
Distorted Elements

Result



Warning! Delete the result sets so you'll be able to change the mesh in the next step.

How:




All

Things to notice

The *I-DEAS List* window indicates that the results set has been deleted.

Fix distorted elements 1 of 1

What: Try to fix any elements with a distortion value less than the value set with *Auto Settings*.

How:

Meshing

Automatic Mesh Checking form

Improve distortion to: 0.5

OK

Check *I-DEAS List*.
Look at the output from the *Tetra Fix* command. If any elements were found with distortion below this value, the program will attempt to fix them.

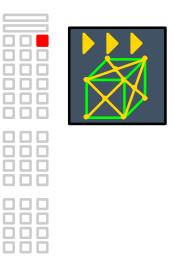
Two other commands to repair distorted tetrahedral elements are *Straighten Edges* and *Move Mid–Nodes*. Both move mid-side nodes to improve distorted elements, since distortion of tetrahedral elements is sensitive to the mid-node position.

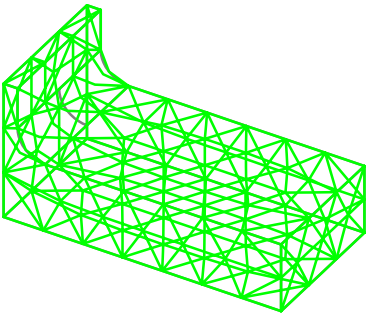
What: Generate the mesh again using automatic mesh checking and improvement options to fix the distortion during the meshing process.

Hint

- *Improve stretch to*: 0.3
- *Improve distortion to*: 0.5

Hint





Things to notice

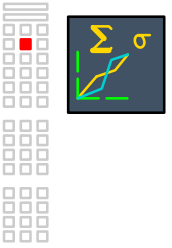
If you calculate distortion values now, you'll see that the element quality is better.

Warning!

The mesh improvement settings apply only to tetrahedral solid elements, not to other element types.

What: Generate a statistical graph of element distortion.

How:

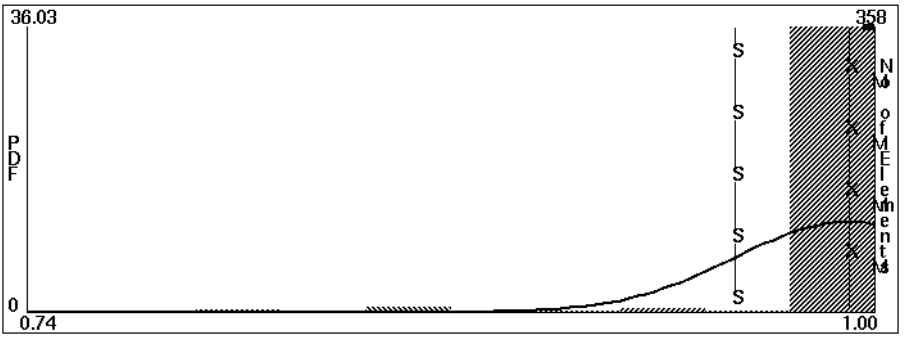


 *All*

Element Quality Statistics form

 *Generate statistics for*: *Distortion*

 (to update the display, if needed)



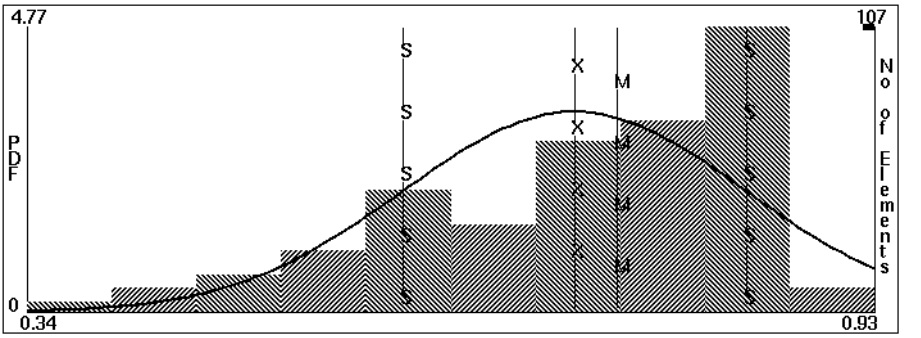
Things to notice

Statistical values for distortion in all the elements are tabulated and graphed, which gives a picture of the overall quality of the model. Most of the elements have very little distortion.

What: Generate a statistical graph of element stretch.

Hint

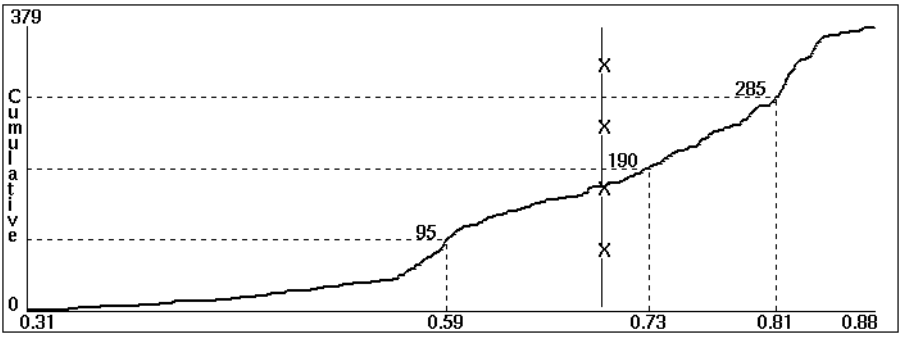
Generate statistics for: *Stretch*



What: Change the display to a cumulative Y-Axis graph.

Hint

Cumulative



Dismiss

These statistical quality functions are also available using *Modify Mesh Preview* and *Quality Checks*.

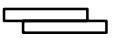
Tutorial wrap-up

You have completed the Checking Element Quality tutorial.

You can delete the FE models and the part, or put them away. Neither are used in any other tutorials.

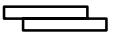
See also...

For additional information on the concepts covered in this tutorial, see the following:

 *Help, Manuals, Table of Contents*

Simulation: Finite Element Modeling User's Guide
- Simulation Techniques and Examples
  - General Techniques and Examples
- Using Simulation Tools
  - Selecting Simulation Entities
  - Using Groups
- Meshing a Model
  - Creating a Mesh
    - Understanding Element Quality Checks
    - Generating Element Quality Statistics

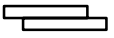
To quickly find definitions of terms used on forms, use:

 *Help, On Context*

What's next?

The remaining Fundamental Skills tutorials present more modeling techniques. After completing these tutorials, use the Advanced Projects tutorials to get an introduction to other element types and solution methods.

To exit this tutorial, select:

 *File*
Exit

Warning!
Do not use the menu in the *I-DEAS Icons* window to exit. Use the File, Exit menu in the Acrobat Reader window.

I-DEAS Master Series™ Online Tutorials

Structural Dynamics Research Corporation
2000 Eastman Drive
Milford, Ohio 45150
(513) 576−2400