ΛΤΛ
ENGINEERING, INC.

Webinar:
Checking Element Quality in Femap

Tommy Board, ATA Engineering

December 11th, 2019

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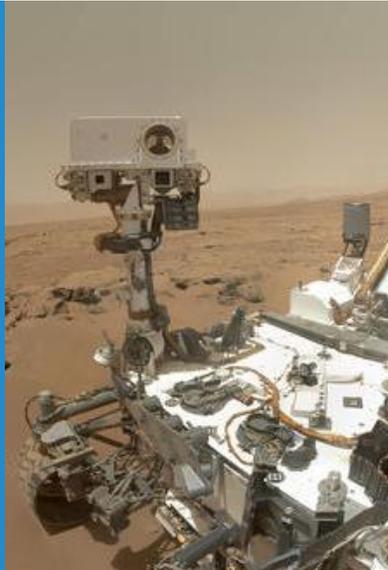
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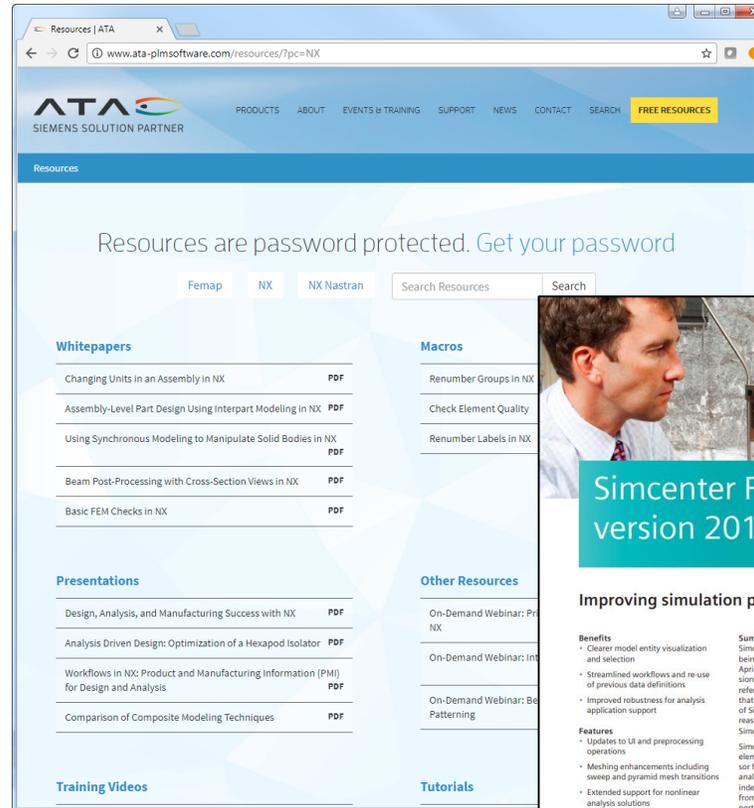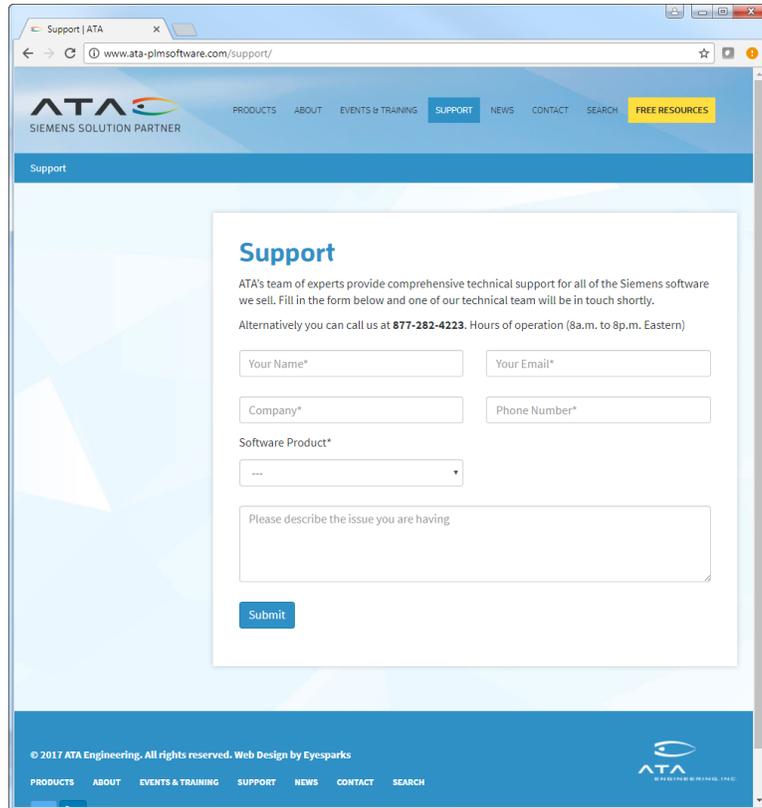# ATA is a Value-Added Reseller for Siemens PLM Software

ATA offers training, free resources, and hotline support for a variety of Siemens products.

➢ Siemens product lines we support include:
  - ➢ STAR-CCM+
  - ➢ Femap
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  - ➢ Simcenter 3D
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➢ Contact the hotline at 877-ATA-4CAE or http://ata-plmsoftware.com/support

➢ Developer of the official Simcenter Nastran training materials

➢ Preferred North American provider of Simcenter Nastran training

➢ Recognized as Smart Expert Partner with validated expertise in Femap and STAR-CCM+

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What's So Bad About "Bad Elements" Anyway?

➢Element quality is key for producing high-quality, accurate results and deliverables

➢Finite element models inherently have error because they use discrete elements to represent continuum bodies

➢Bad elements deviate considerably from equilateral shapes and further reduce model accuracy

➢This webinar will include:
  ➢What do bad elements look like?
  ➢How to identify bad elements in Femap
  ➢Methods to improve those bad elements
  ➢Live demo in Femap v2019.1, but commands are similar across different versions

Poor Element Quality Comes in Different Forms

➤Measures for quantifying element quality include:

Aspect Ratio

Taper
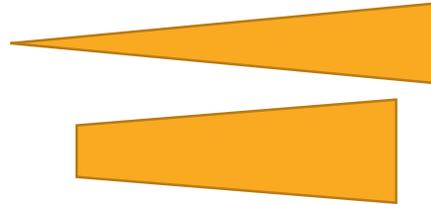
Element Warping
(out-of-plane deviation)
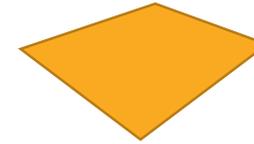
Interior Angles
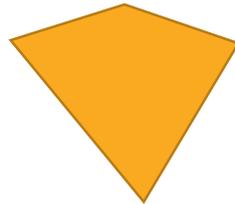
Skew

Jacobian
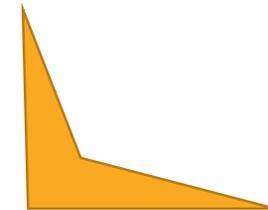
➤Jacobian determinant:

  ➤Negative values occur at node if corresponding interior angle is greater than 180˚

  ➤Solution will fail with negative determinant

  ➤Examples:

    ➤ When a triangle starts to flatten into a straight line

    ➤ When a quad starts to look like a triangle

➢ In the Menu bar, Tools -> Check -> Element Quality

➢ Select the elements of interest

➢ The next dialog box has two tabs, Femap and NX Nastran
  ➢ If NX Nastran is your solver, use this tab with the default checks
  ➢ Femap checks may be helpful if you are using a different solver. They have different default values and some elements may fail under those that would not fail with Nastran checks.
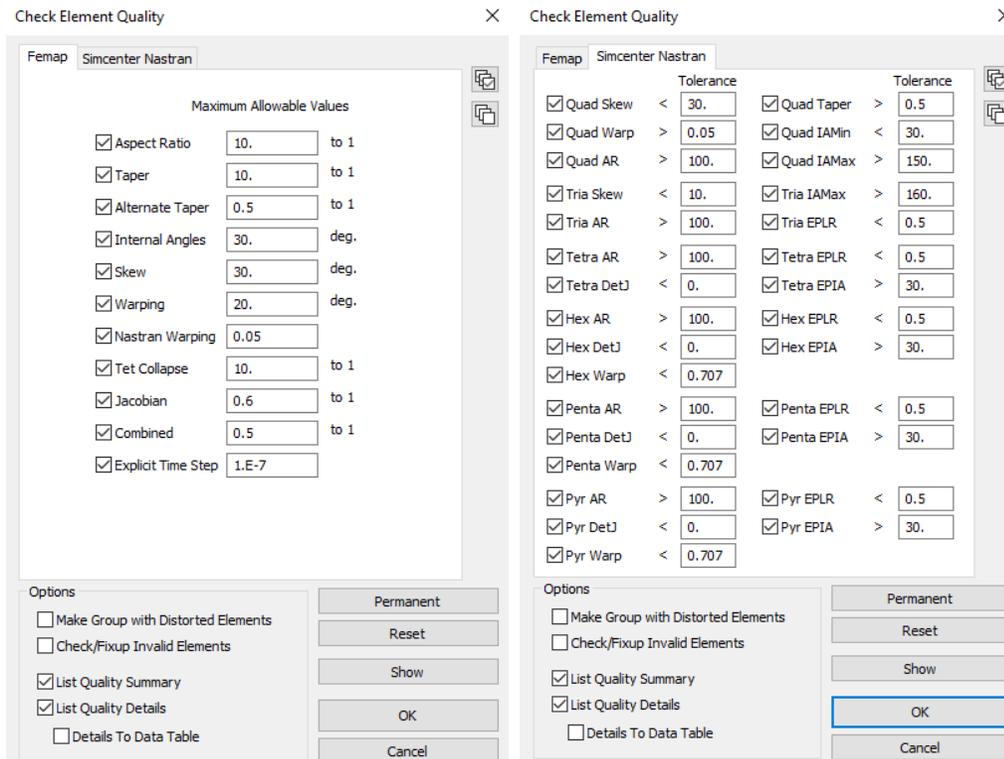
You can also create a contour of good/bad elements in Meshing Toolbox under Surface Mesh Quality:
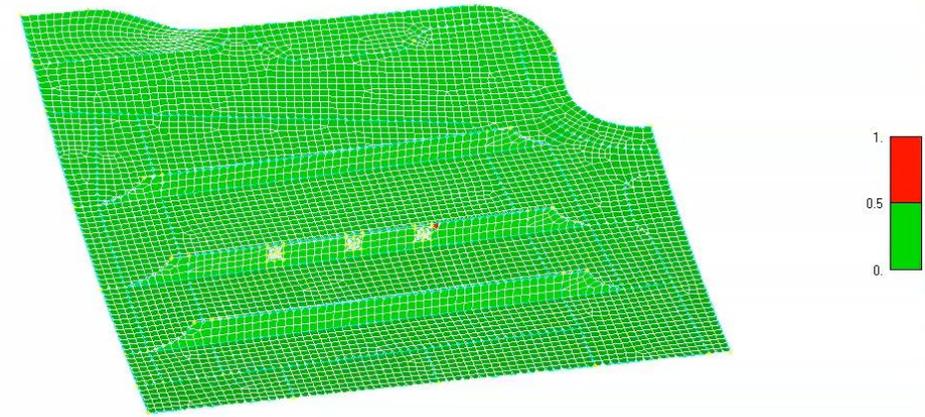
Output Set: Surface Mesh Quality
Elemental Contour: Quad Taper

How to Check Element Quality in Nastran

You should do this **in addition** to checking quality in Femap

➤F06 file will list out poor quality elements

```
TOLERANCE LIMITS ARE:  SA =  30.00, IA(MIN) =  30.00, IA(MAX) = 150.00, WF =   0.05, TR =   0.50, AR = 100.00
(xxxx = LIMIT VIOLATED)
ELEMENT TYPE     ID       SKEW ANGLE     MIN INT. ANGLE   MAX INT. ANGLE   WARPING FACTOR   TAPER RATIO    ASPECT RATIO
   QUAD4      302104       76.84            54.56            118.99           0.00            0.53 xxxx        1.98
   QUAD4      302252       69.59            47.02            115.35           0.00            0.55 xxxx        2.29
   QUAD4      302253       78.66            55.82            122.06           0.00            0.55 xxxx        1.92
   QUAD4      302255       83.86            60.56            124.48           0.00            0.53 xxxx        1.92
   QUAD4      302256       71.23            47.73            120.93           0.00            0.59 xxxx        2.30
   QUAD4      302258       83.25            60.08            124.90           0.00            0.54 xxxx        1.81
   QUAD4      302260       70.83            47.88            120.48           0.00            0.59 xxxx        2.23
   QUAD4      302277       75.82            51.29            124.96           0.00            0.59 xxxx        2.20
   QUAD4      302279       84.12            60.21            127.33           0.00            0.55 xxxx        1.86
```

'xxxx' indicates an element warning; 'FAIL' is printed for elements that fail the NASTRAN element quality check

➤Nastran will sometimes flag elements that didn't get flagged by pre-processor element quality checks, and vice versa

➤What if the .f06 file didn't print out all the bad elements? In case control, add this line:

➤GEOMCHECK MSGLIMIT = 5000

CheckElems API Tool

➢Available as a Femap API program

➢Reads an .f06 file and adds any elements that exceeded the solver's tolerances to a new group in Femap

➢Located on our Siemens PLM Website:

    ➢ https://www.ata-plmsoftware.com/resources/check-element-quality/

    ➢ Password: plmsoftware

    ➢ Click "Download the Femap API"

    ➢ Save the file "CheckElems.exe" into your local Femap API directory

➢ Make a group of all the bad elements to visually understand how to improve them

➢ Bad geometry leads to bad elements

➢ Things to Try:

  ➢ Change the element size

  ➢ Free vs. mapped meshes

  ➢ Add geometric partitions

  ➢ Meshing Toolbox has a variety of options

  ➢ Manual meshing (details on next slide)

  ➢ For solid meshes, seed faces with 2D Plot-Only Planar elements

  ➢ For a larger model, check quality of separate meshes before connecting them together
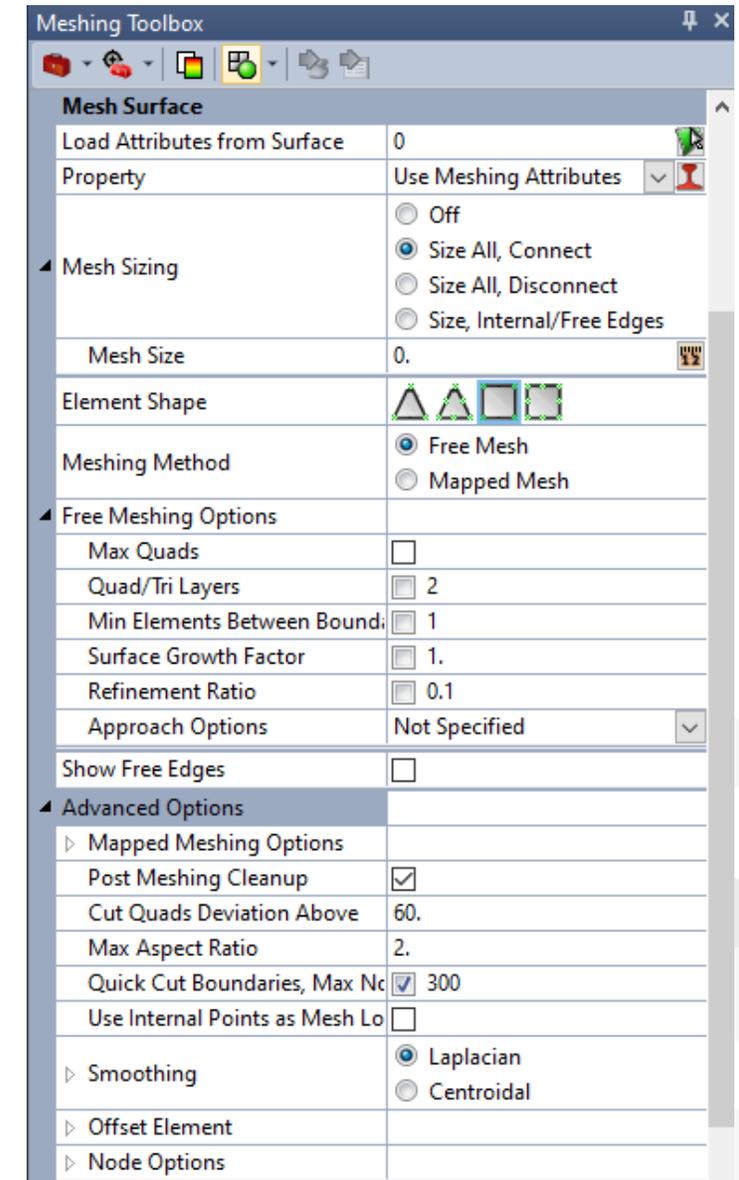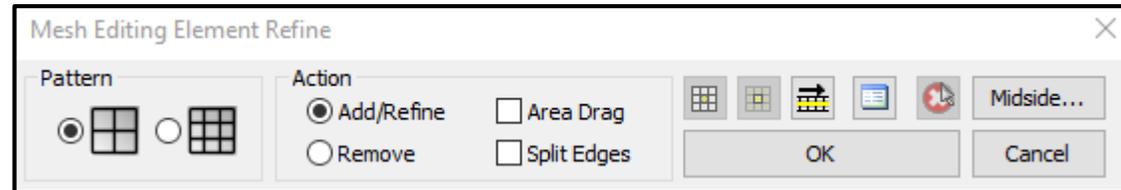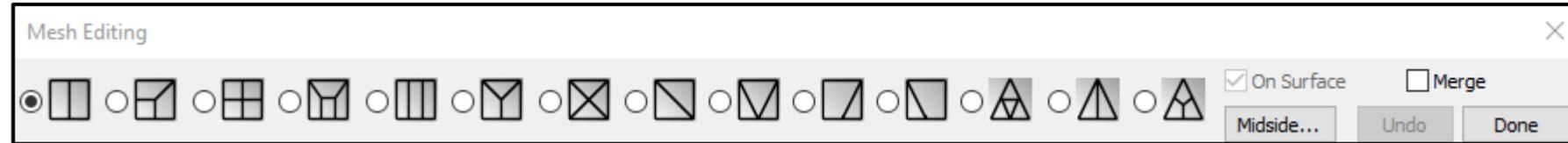
Femap Manual Meshing Commands

Useful for mesh improvements when geometry is not available

➢ Mesh->Editing

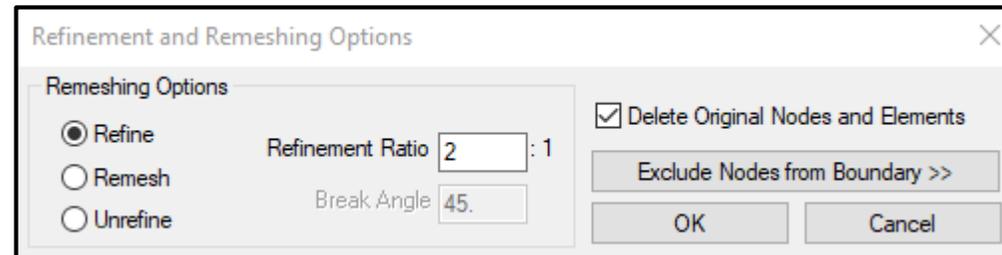 ➢ Interactive

  ➢ Split

  ➢ Element Refine

➢ Mesh->Remesh
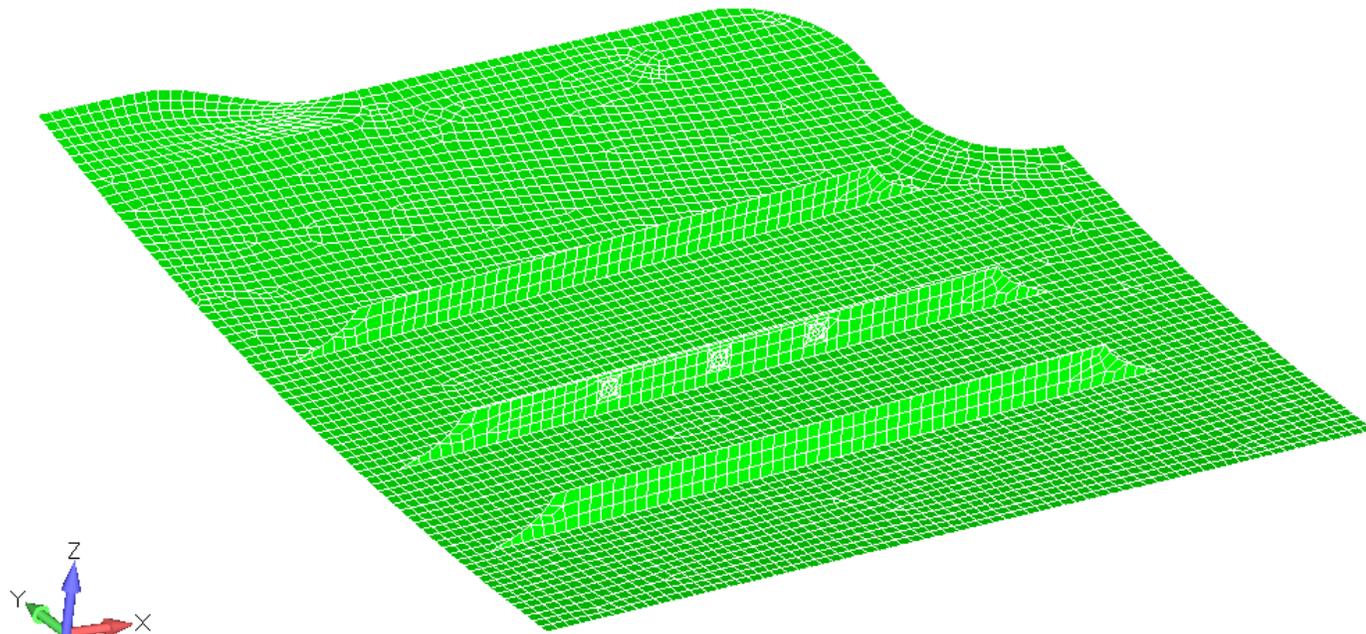
  ➢ Refine

  ➢ Update

  ➢ Un-refine

Be careful to ensure the mesh stays connected after manual meshing

Output Set: Surface Mesh Quality
Elemental Contour: Quad Taper

Questions?

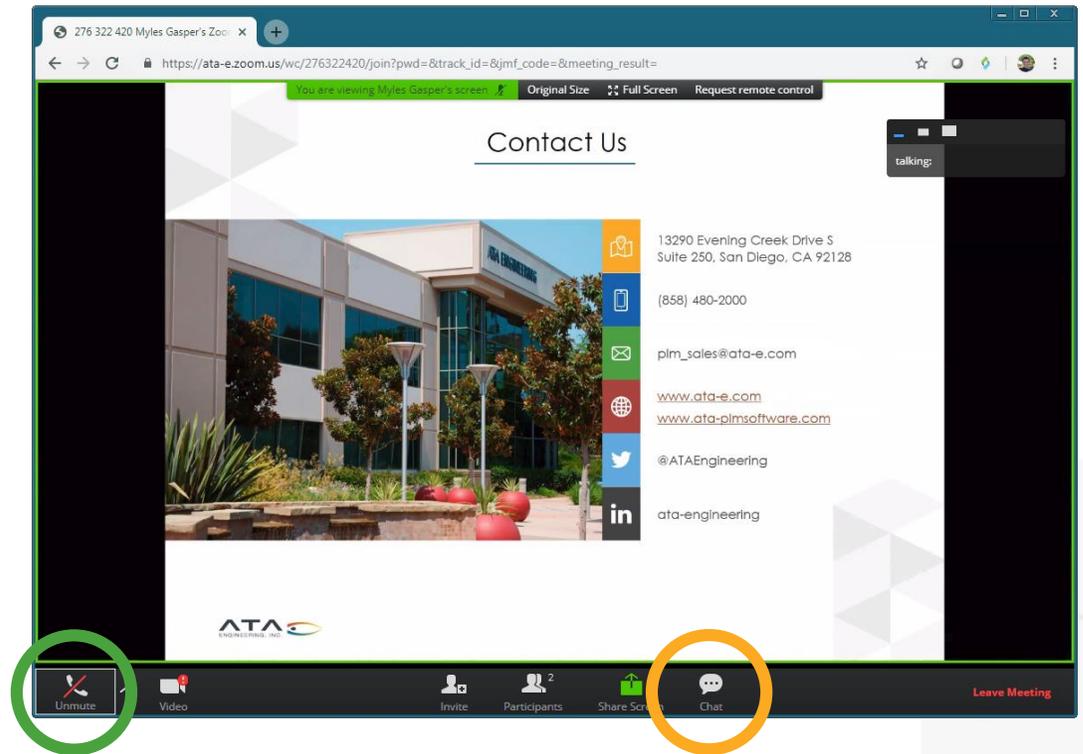Submit questions in the chat or unmute yourself now

Zoom Application
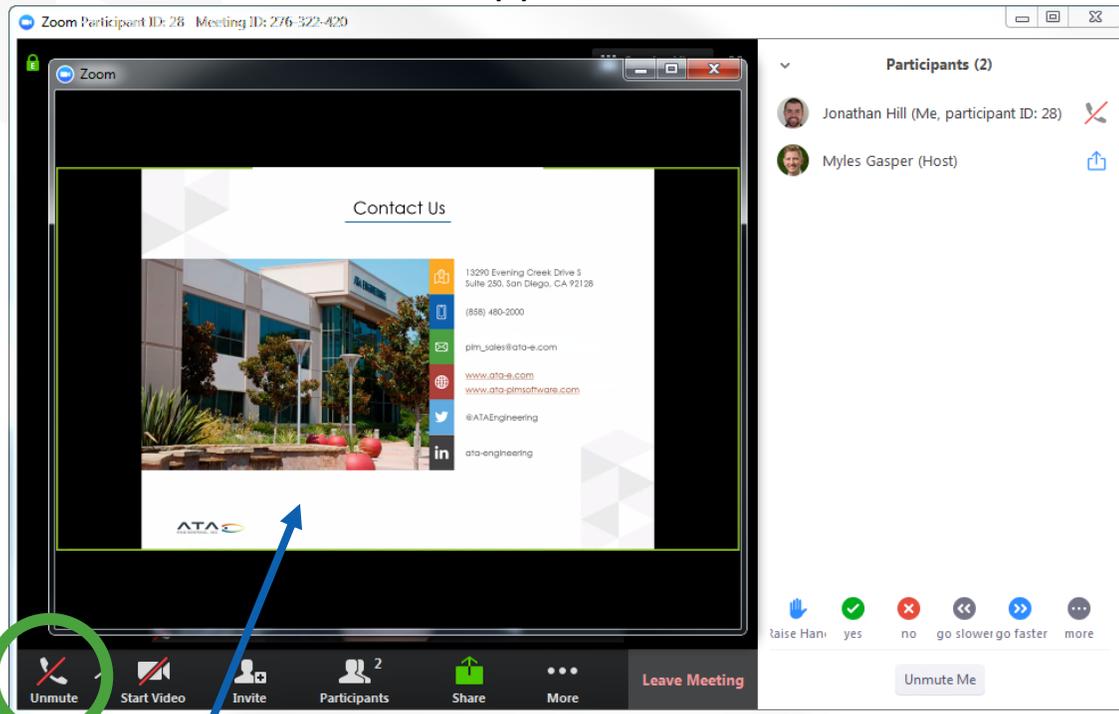
Web Interface

Screenshare in separate window

Chat is available under More

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